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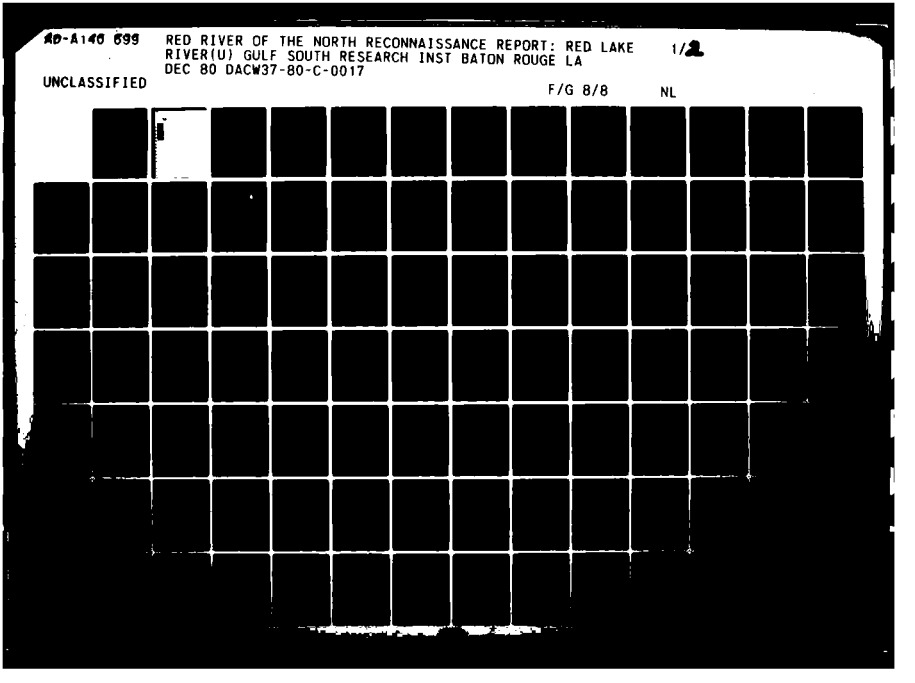

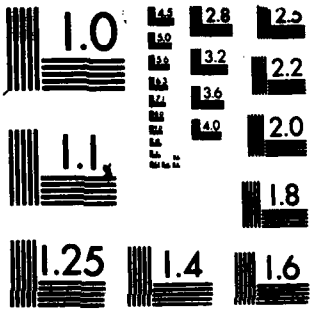

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This report is one of 23 subbasin reports produced by the St. Paul District Corps of Engineers in connection with a reconnaissance report for the whole of the Red River Basin. The reconnaissance report is itself part of the overall Red River of the North study, which was initiated by Congress in 1957 in order to develop solutions for flooding problems within the basin. The purpose of a reconnaissance study is to provide an overview of the water and related land resource problems and needs within a particular geographic area, to identify planning objectives, to assess potential solutions and

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problems, to determine priorities for immediate and longrange action, and to identify the capabilities of various governmental units for implementing the actions.

The information developed in this report has been combined with information developed in the other subbasin reports to produce a main report covering the basin as a whole. The various flood control measures discussed in this and in other subbasin reports are combined in the main report to develop the outline of an integrated flood control plan for the basin within the context of a comprehensive plan.

The Red Lake River Subbasin occupies 5,970 square miles of the central Minnesota portion of the Red River Basin. It is the largest of all the subbasins and includes all of Red Lake County and portions of Marshall, Pennington, Clearwater, Koochiching, Itasca, Mahnomen, Beltrami, Polk, and Lake of the Woods counties.

The major waterway is the Red Lake River, which has its source in Lower Red Lake. The river is 196 miles long from its source to its confluence with the Red River of the North on the Minnesota-North Dakota border at East Grand Forks.

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RECONNAISSANCE REPORT: RED RIVER OF THE NORTH BASIN, RED LAKE RIVER SUBBASIN

Prepared for:

U.S. Army Corps of Engineers
St. Paul District
St. Paul, Minnesota

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This report is one of 23 subbasin reports produced by the St. Paul District Corps of Engineers in connection with a reconnaissance report for the whole of the Red River Basin. The reconnaissance report is itself part of the overall Red River of the North Study, which was initiated by Congress in 1957 in order to develop solutions for flooding problems within the basin.

The purpose of a reconnaissance study is to provide an overview of the water and related land resource problems and needs within a particular geographic area, to identify planning objectives, to assess potential solutions and problems, to determine priorities for immediate and long-range action, and to identify the capabilities of various governmental units for implementing the actions.

The Red Lake River Subbasin is a water resource planning unit located in the central Minnesota portion of the Red River Basin. This report describes the social, economic, and environmental resources of the subbasin, identifies the water-related problems, needs, and desires, and suggests measures for meeting the needs, particularly in the area of flood control.

The report was prepared almost entirely on the basis of secondary information. However, some telephone contacts were made to verify information and to acquire a more complete picture of local conditions. The comprehensive reports available on the subbasin include the: Red Lake River Basin Feasibility Study (an unpublished collection of papers, St. Paul District Corps of Engineers, 1975) and Red Lake Watershed District, Overall Plan (which was published by the Red Lake Watershed District in 1972). Other published sources on the subbasin include:

1. Survey Report for Major and Local Drainage, Thief River, Minnesota, which was published by the U.S. Department of Agriculture, Soil Conservation Service in 1962 and is a report on proposed drainage projects and estimates of costs and benefits.
2. The Environmental Biological Aspects of Water Management Alternatives in the Red Lake River Subbasin, which was published by the Center for Environmental Studies at Bemidji State College, Bemidji, Minnesota in 1973 and is a study of the effects of a water management project above Crookston on the terrestrial and aquatic ecosystems of the area.

3. Plan of Survey, Interim Report on Red Lake River for Water and Related Land Resource Development, which was published by the St. Paul District Corps of Engineers in 1964 and summarizes various flood control projects in the subbasin, describes the area briefly, and recommends an investigation of water and related land resource development.

4. Hydropower and Flood Control Potential of the Red Lake River, A Red River of the North Tributary, which was published by the Red Lake River Basin Planning Commission in 1979 and discusses hydropower potentials in the subbasin.

5. Flood Control and Major Drainage, General Design Memorandum, Lost River, Minnesota, which was published by the St. Paul District Corps of Engineers in 1960 and is a summary of proposed flood control measures on Lost River.

6. Annual Report, Year Ending December 31, 1978, which was published by the Red Lake Watershed District in 1979 and describes the activities of the Board of Managers of the Watershed District.

7. Burnham Creek Watershed, Minnesota, Preliminary Investigation Report, which was published by the Soil Conservation Service in 1979 and describes the watershed, lists its problems and needs, and proposes measures to reduce flooding and improve drainage.

8. Survey Report on Flooding and Major Drainage Problems on Ruffy Brook and Lost River, Minnesota, which was published by the St. Paul District Corps of Engineers in 1952 and discusses the damages from flooding and proposed measures to reduce flooding.

9. Flood Control and Major Drainage, General Design Memorandum, Ruffy Brook, Minnesota, which was published by the St. Paul District Corps of Engineers in 1960 and describes a proposed channel enlargement and realignment of Ruffy Brook.

10. 1979 Priorities Report, which was published by the Upper Mississippi River Basin Commission in 1979 and provides information concerning flood prevention in the subbasin.

11. Memorandum Concerning Emergency Snagging and Clearing for Flood Control, Poplar River, Minnesota, a Reconnaissance Report Supplement, which was published by the St. Paul District Corps of Engineers in 1979 and discusses the possible benefits of the project.

12. Memorandum on Flood Control Reconnaissance Report, Thief River, Minnesota, which was published by the St. Paul District Corps of Engineers in 1967 and discusses flooding problems along Thief River.

13. Application for Assistance in Planning and Carrying Out Works of Improvement Under the Watershed Protection and Flood Prevention Act, Lost River Watershed, which was published by the Red Lake Drainage and Conservancy District in 1958 and is an application for Federal assistance.

14. Application for Planning Assistance Under the Watershed Protection and Flood Prevention Act, Lost River Watershed, which was published by the Red Lake Drainage and Conservancy District in 1955 and is an application for assistance in developing a work plan for flood control in the watershed.

15. Application for Assistance in Planning and Carrying Out Works of Improvement Under the Watershed Protection and Flood Prevention Act, Badger Creek Watershed, which was published by the East Polk and Red Lake County soil and water conservation districts in 1971 and is an application for Federal assistance.

16. Application for Planning Assistance Under the Watershed Protection and Flood Prevention Act, Mud River Watershed, which was published by the Marshall-Beltrami Soil Conservation District in 1956 and is an application for assistance in developing a work plan for the watershed.

17. Floodplain Information, Red Lake River, Crookston, Minnesota, which was prepared by the St. Paul District Corps of Engineers in 1974 and includes a history of flooding in Crookston and identifies areas that are subject to floods.

18. Archaeological Investigations in the Red Lake River, Minnesota Proposed Dam and Reservoir Project for U.S. Army Corps of Engineers, which was published by the University of Minnesota in 1973 and discusses sites found in the area of the proposed dam and reservoir.

19. Red Lake River Subbasin Feasibility Study for Flood Control and Related Purposes, which was published in 1977 by the St. Paul District Corps of Engineers.

In addition, the subbasin received partial coverage in the Souris-Red-Rainy River Basins Comprehensive Study, which was published by the Souris-Red-Rainy River Basins Commission in 1972, and in the Red River of the North Basin Plan of Study, which was published by the St. Paul District Corps of Engineers in 1977.

The information developed in this report has been combined with information developed in the other subbasin reports to produce a main report covering the basin as a whole. The various flood control measures discussed in this and in other subbasin reports are combined in the main report to develop the outline of an integrated flood control plan for the basin within the context of a comprehensive plan.

II. DESCRIPTION OF STUDY AREA

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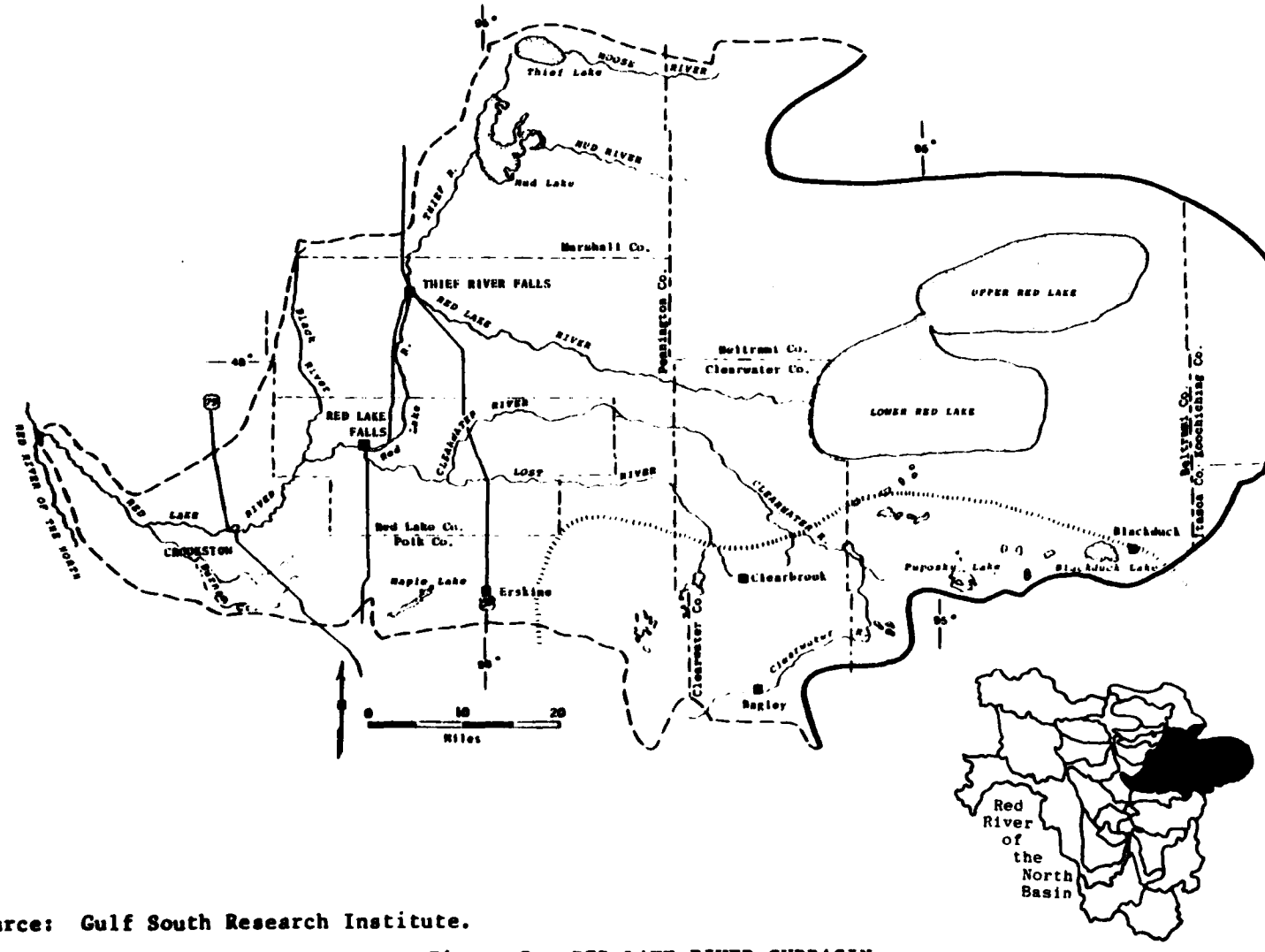
The Red Lake River Subbasin occupies 5,970 square miles of the central Minnesota portion of the Red River Basin. It is the largest of all the subbasins and includes all of Red Lake County and portions of Marshall, Pennington, Clearwater, Koochiching, Itasca, Mahnomen, Beltrami, Polk, and Lake of the Woods counties. It is bordered on the south by the Sand Hill and Wild Rice-Marsh subbasins, on the west by the Main Stem Subbasin, and on the north by five subbasins: Snake, Middle, Tamarac, Two Rivers, and Roseau. The eastern margin is the border of the Red River Basin. The subbasin has achieved a legal status through the formation of the Red Lake Watershed District.

The subbasin is divided into three distinct physiographic regions. In the southeast there is a glacial moraine with hills and depressions. In the west there is a glacial lake plain that is extremely flat. The eastern edge of the lake plain ends in a series of narrow beach ridges running in a north-south direction. To the east of the beach ridges is a glacial lake-washed till plain that is flat to gently rolling, with shallow bogs and peat areas. Both the lake plain and till plain areas were covered many thousands of years ago by glacial Lake Asassiz. Upper and Lower Red Lakes are remnants of this glacial lake.

The topography of the subbasin ranges from 800 feet above mean sea level in the western end at the confluence of the Red Lake River and the Red River of the North to 1,600 feet above mean sea level in the south central part. In general, the southern part of the area, which is made up of northern Clearwater County and a small tract of land in Mahnomen County, has the highest elevation, ranging from approximately 1,260 to 1,600 feet above sea level. The northern part of the subbasin is rather flat, ranging from 1,200 feet on the east to 1,140 feet on the west. The lake plain in the western part of the subbasin is also flat, ranging from 800-920 feet.

The major waterway is the Red Lake River, which has its source in Lower Red Lake. The river flows in a northwesterly direction until meeting



Source: Gulf South Research Institute.

Figure I. RED LAKE RIVER SUBBASIN

the Thief River, at which point it flows due south in the beach ridge area and then curves upward in the lake plain area until it meets the Red River. The river is 196 miles long from its source at Lower Red Lake to its confluence with the Red River of the North on the Minnesota-North Dakota border at East Grand Forks. The slope of the river is about 2 feet per mile above Crookston and about 1.1 feet per mile below Crookston. The principal tributaries are the Clearwater and Thief Rivers, which are 91 miles long and 125 miles long, respectively. Other tributaries include Black River, Oya and Burnham creeks, and several minor creeks.

III. PROBLEMS, NEEDS, AND DESIRES

III. PROBLEMS, NEEDS, AND DESIRES

The primary water-related problems, needs, and desires in the Red River Basin are flood control, fish and wildlife conservation and enhancement, recreation, water supply, water quality, erosion control, irrigation, wastewater management, and hydropower. Various water-related problems, needs, and desires have been identified for the Red Lake River Subbasin in previous planning reports on the basis of analysis of conditions and public agency comments. The list of problems, needs, and desires for the subbasin is the same as the list for the Red River Basin as a whole. Each problem is discussed separately below, with an emphasis on flooding problems.

Flooding Problems

Nature of the Problems

Floods on the Red Lake River usually occur in April and May in conjunction with spring snowmelt. Spring rains occurring at such times serve to extend the duration of high flows or result in additional high peak flows. Several large lakes and extensive marsh areas also tend to extend the duration of snowmelt floods. Overbank flood stages usually persist for several days, with widespread flooding on the Red River Valley plain below Grand Forks lasting as long as four to six weeks.

Although agriculture is less pronounced than in adjacent subbasins, spring snowmelt floods do force delays in planting operations that are reflected in reduced crop yields. In view of the relatively short growing season, water standing on the land too long may make it impossible to engage in planting operations altogether.

Flood damage also occurs from high intensity summer rains. Although they occur less often than spring snowmelt floods, these summer floods are characterized by high peak flows that cause urban and agricultural damage. The condition of the soil is an important factor relative to the degree of flooding in that high soil moisture or frozen soil conditions prior to heavy rains and/or snowmelt result in greater runoff.

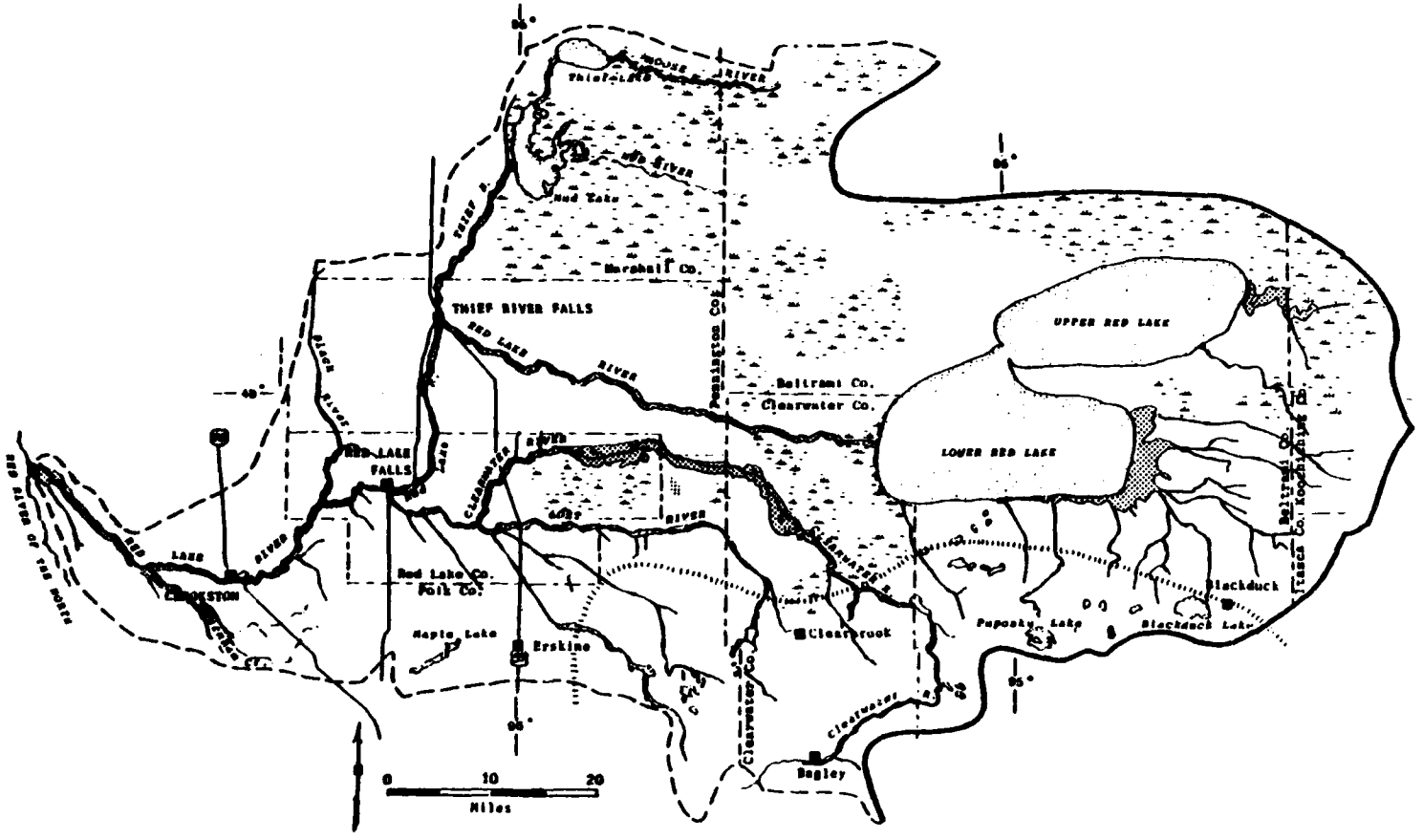
Two separate types of flooding occur: the most damaging type associated with river bank overflow (overbank flooding) and another type caused by runoff from snowmelt or heavy rainfall impounded by plugged culverts and ditches within sections of land bounded by roadways on earthen fill (overland flooding). In overland flooding, the trapped water slowly accumulates until it overflows the roadways and inundates section after section of land as it moves overland in the direction of the regional slope until reaching river or stream channels.

The topography of the subbasin has a direct influence on flooding problems. In the glacial moraine in the southeastern part of the subbasin, floodplains are generally narrow in width and small in extent. In the extremely flat glacial lake plain in the west, tributaries converge and the floodplain widens appreciably in extent. To the east of the lake plain across a series of north-south beach ridges is a glacial lake-washed till plain. The plain is flat to gently rolling, with extensive shallow bogs and very little in the way of a defined floodplain.

An important aspect of subbasin flooding is its usual close synchronization with the arrival of the Red River crest at the confluence of the two rivers and the resultant aggravation of flooding conditions at Grand Forks, East Grand Forks, and Red River downstream reaches. Since the Red Lake River contributes greater volumes of floodwater to the Red River of the North than any other tributary (15.3 percent of the basin total), this is particularly significant. To make matters worse, ice jams in the vicinity of Crookston often increase flood crests by several feet.

Location and Extent

Figure II depicts the 100-year floodplain for the entire subbasin. Prior to this study, no attempt had been made to publish even a generalized delineation. A number of sources were investigated in order to arrive at the present delineation. Among these were: (1) U.S. Geological Survey (USGS) Flood Prone Area Maps at 1:24,000 scale; (2) Federal Insurance Administration flood maps; (3) published secondary sources describing flooded areas; and (4) USGS 7 1/2 minute topographic maps.



Source: Gulf South Research Institute.

Figure II. 100-YEAR FLOODPLAIN

The map is thus a composite of available sources supplemented by inferences where necessary. Because the sources were incomplete and based on surveys differing in purpose and accuracy, it should be understood that Figure II constitutes a generalized delineation intended only for planning purposes. A more complete description of sources and limitations is given in Appendix A.

According to this initial delineation, the principal Red Lake River floodplain encompasses some 32,000 acres in both the lake plain and till plain. Another 70,000 acres is encompassed by tributaries: Thief, Clearwater, Lost, and a group of smaller rivers east of Upper and Lower Red Lake, bringing the overall total to 102,000 acres. Approximately 324,000 acres of wetland are also shown in Figure II but are not included in the floodplain delineation.

The Red Lake River floodplain located in the glacial lake plain totals 18,000 acres and includes 2,000 acres commonly associated with the main stem of the Red River. The 100-year floodplain below Crookston is generally a half-mile in width. The upper portion of the river's floodplain in the till plain comprises an additional 14,000 acres.

In this same physiographic area, narrow floodplains are found along the Thief River (2,000 acres) and Lost River (12,000 acres). Floodplain associated with the Clearwater River totals 28,000 acres and is most pronounced in Northeastern Red Lake and Polk and northern Clearwater counties. Here, the floodplain varies from a half-mile to two-and-a-half miles in width after emerging from the glacial moraine area.

Nine other smaller rivers and creeks bordering the southern and eastern lake shores account for another 28,000 acres of floodplain. The two distinct areas shown in Figure II at this location include a sustantial amount of wetland area as represented on flood insurance maps. This is, of course, apart from surrounding wetlands denoted by the marsh pattern.

Flood Damages

The primary areas affected by flooding throughout the subbasin's floodplain are urban, agricultural, and environmental in nature. Recurrent

flooding of urban development in the town of Crookston is the most critical flooding problem in the subbasin. Cultivated areas in the narrow floodplain of the Red Lake River are scattered and limited in size to the extent that agricultural flood damages are relatively minor. Only urban and rural damages are taken into consideration in the computation of average annual damages.

Present average annual flood damages in the subbasin are $2.0 million. In comparison to the other subbasins, this is a sizeable figure, accounting for six percent of the Red River of the North basinwide total. Average annual flood damages are divided into two basic classifications: urban and rural. Urban damages include damages to residences, businesses (commercial and industrial) and public facilities (streets, utilities, sewers, etc.). Rural flood damages include damages to crops, other agricultural assets (fences, machinery, farm building, etc.), and transportation facilities. Urban damages account for 87 percent of the total average annual damages in the subbasin, and rural damages account for the remaining 13 percent.

Urban damages sustained during the 1975 flood event amounted to $57,200. The flood event of 1979 resulted in $650,000 in urban damages at Crookston. In comparison, average annual urban flood damages are estimated at $1.8 million. A more detailed breakdown of these urban flood damage figures appears in Table 1. Urban damages resulting from the flood event of 1975 include $28,600 in residential damages, $22,900 in damages to businesses, and $5,700 in public damages. Urban flood damages resulting from the 1979 flood event included $325,000 in residential damages, $260,000 in business related damages, and $65,000 in public damages. Estimated average annual urban flood damages include $876,800 in residential damages, $701,400 in business damages, and $175,400 in public damages.

Average annual rural flood damages along with the rural flood damages sustained in the flood events of 1975 and 1979 appear in Table 2. The 1975 flood event resulted in $438,100 in crop damages, $197,900 in other agricultural damages, and $79,400 in transportation damages. The flood event of 1979 resulted in $368,000 in crop damages, $64,000 in other agricultural damages, and $250,000 in transportation damages. Total rural flood damages incurred in the flood events of 1975 and 1979 were

Table 1

RED LAKE RIVER SUBBASIN, ESTIMATED 1975, 1979
AND AVERAGE ANNUAL URBAN FLOOD DAMAGES
(Thousands of 1979 Dollars)

	Year		
Category	1975	1979	Average Annual
Residential	$28.6	$325.0	$ 876.8
Business	22.9	260.0	701.4
Public	5.7	65.0	175.4
Total	$57.2	$650.0	$1,753.6

Sources: Red River of the North Basin Plan of Study, April 1977; Post Flood Reports 1975, 1979; and Gulf South Research Institute.

Table 2

RED LAKE RIVER SUBBASIN ESTIMATED 1975, 1979
AND AVERAGE ANNUAL RURAL FLOOD DAMAGES
(Thousands of 1979 Dollars)

	Year		
Category	1975	1979	Average Annual
Crop	$438.1	$368.0	$197.2
Other Agricultural	197.9	64.0	65.7
Transportation	79.4	250.0	9.1
Total	$715.4	$682.0	$272.0

Sources: Red River of the North Basin Plan of Study, April 1977; Post Flood Reports 1975, 1979; and Gulf South Research Institute.

$715,400 and $682,000, respectively. Estimated average annual rural flood damages in the subbasin include $197,200 in crop damages, $65,700 in other agricultural damages, and $9,100 in transportation damages. Total average annual rural flood damages are $272,000.

Environmental Concerns

Much of the original grasslands in the western portion of the subbasin have been cleared for agricultural uses. Some bluestem prairie can be found west of the Red Lakes along the Red Lake River on lands that have not been farmed. These areas need to be protected, if at all possible, because of their rarity within the Red River of the North Basin, and because of their importance for flora and fauna depending upon the prairie ecosystem. Destruction of wetlands is also a significant problem that has resulted from drainage for subsequent conversion to agricultural lands and channelization. Although wetland inventory data is limited for the subbasin, information exists that indicates that the number and acres of Type 3, 4, and 5 wetlands in Polk County were reduced by 10.4 and 8.0 percent, respectively, during the 10-year period from 1964 to 1974 (See Table 11). In addition, roughly 50,000 to 60,000 acres of wetland habitat have also been adversely affected or destroyed as a result of early marsh drainage and the Red Lake and Clearwater River channelization projects. Protection, conservation, and enhancement needs to be extended to these highly beneficial and sensitive ecosystems. Additionally, the peatlands and bogs around upper Red Lake need to be protected because of their uniqueness and primitive setting (U.S. Army Corps of Engineers, 1975, 1977; U.S. Fish and Wildlife Service, 1980; Mann, 1979).

The woodlands of the subbasin also need to be conserved, protected, and enhanced where possible. Forested areas comprise 31.7 percent (1,211,194 acres) of the subbasin's total area. This is the most heavily wooded subbasin on the Minnesota side of the Red River Basin. These habitats are very significant because of their value for wildlife and because of their large areal extent. In the western portion, clearing for agricultural development has reduced woodland vegetation to the floodplains of streams or to scattered woodlots. Studies have shown that the vegetated corridors along the streams provide a basic ecological relationship between the eastern and western portions of the subbasin as an area for animal population movement (Elwell et al., 1973; U.S. Fish and Wildlife Service, 1980; data from the Minnesota Land Management Information Service).

Aquatic biota problems are related to low flows in the Red Lake River and some water quality parameters. These parameters include high levels of total suspended solids, BOD, and oil and grease, excessive concentration of fecal coliforms (in violation 40-50 percent of the time) and excessive turbidities (in violation 32 percent of the time). Although the river supports a very good fisheries, these problems have probably degraded the quality of the river for aquatic biota to some extent. Additional problems that have been expressed include the adverse impact of the dam at the outlet of lower Red Lake on the fisheries of the Red Lakes (a debatable issue) and the reduction in sport fishery below the dam as a result of channelization (U.S. Army Corps of Engineers, 1975; U.S. Fish and Wildlife Service, 1979a). There is a need to improve these conditions, where possible, to improve aquatic habitats for aquatic organisms and wildlife.

Recreation Problems

There are adequate water-based and water-related recreational opportunities in the subbasin. Problems related to recreation do not arise from the lack of large water bodies or forest tracts as in many parts of the Red River Basin, but from natural conditions and processes, certain practices by man that diminish quality, and the distribution of prime recreational areas in relation to population centers.

Many of the lakes in the moraine area are shallow and are not suitable for recreation. Unfavorable shorelines and lake bottoms limit several larger lakes, such as Puposky and Thief lakes, for recreational use. Siltation from agricultural runoff is not as pronounced in this subbasin as in other areas of the Red River Basin, but does present some problems. Municipal wastes discharged into Blackduck Lake have diminished the water quality, but the town of Blackduck is currently examining alternative means of disposal or treatment of wastes.

The major problem of the area is the lack of water-based recreational opportunities near the population centers in the western portion of the subbasin, particularly near Crookston. All of the proposed recreation sites are located in the vicinity of Crookston, Red Lake Falls, or Thief River

Falls; however, the only water-based recreational sites planned are two access points to Red Lake and Clearwater rivers. The topography of the flat western portion of the subbasin limits the potential for reservoir development.

It should be noted that boating on Upper and Lower Red Lakes is limited by the size and shallow depth of the lakes, which creates safety hazards during windy conditions. Resort development has not occurred because the majority of shoreline property is included in the Red Lake Indian Reservation and is, therefore, unavailable for recreational purposes for most of the subbasin residents. Access to the western portion of the lakes is permitted, however, by payment of a fee to the reservation.

Water Quality Problems

The Upper Mississippi River Basin Commission (1977) cited the main water quality problems in the Red Lake River as high consumptive demands during periods of low flow, municipal or industrial effluents, and agricultural and feedlot runoff. Fecal coliform densities are a substantial problem, probably arising from inadequate treatment facilities. Wastewater treatment problems will be discussed in a later section. High levels of TSS and oil and grease also degrade the water quality. The TSS concentrations could be caused by natural factors or point or nonpoint sources. Although the Minnesota Pollution Control Agency (1975) considers the Red Lake River to have adequate flows, the Upper Mississippi River Basin Commission (1977) lists insufficient stream flows during the summer, fall, and winter months as a water quality problem. The low flows reduce the river's assimilative capacity (Upper Mississippi River Basin Commission, 1977; Minnesota Pollution Control Agency, 1975).

Many groundwater supplies throughout the subbasin contain excessive amounts of iron and manganese. The deeper bedrock aquifer contains waters that are highly saline. At times, deficiencies in groundwater supplies create potential problems (Upper Mississippi River Basin Commission, 1977).

Water Supply Problems

The smaller communities and farm populations obtain their water supply from groundwater. Although this water is usually of good quality,

traces of iron and sulphates were found in all wells tested by the Minnesota Department of Natural Resources, Division of Waters, Soils, and Minerals.

Red Lake River is used by Crookston and Thief River Falls as a water supply source. It is necessary to filter and purify all river water for domestic and industrial purposes. During high spring runoff, water purification problems are increased. A low flow period generally occurs in the late summer or early fall because of low precipitation. During the winter months, when the rivers and lakes are frozen, another low flow occurs. The city of Crookston reported low water supply during the late summer months. Two new wells are in the planning stages, according to local officials, but location disputes have brought the case to the State Supreme Court.

Erosion Problems

Soils in the subbasin are susceptible to drifting, wind erosion, and water erosion. Water erosion is most severe in the lake plain and moraine areas during the spring runoff season. The silt, clay, and other fine soil particles are carried into the streams and rivers and produce siltation problems in the stream channels. Wind erosion results in sedimentation fills or partial fills of surface drainage systems and main outlet ditches, causing additional flooding and drainage problems. Soils treated with pesticides and nutrient enrichments are carried into lakes and streams, reducing the water quality and decreasing the water holding capacity. This severely limits the municipal water supply and recreational potentials in the subbasin.

Irrigation

Irrigation practices in Minnesota have been increasing steadily since the mid-1930's. Many farmers who have proper soil and water conditions invest in an irrigation system in order to reduce the climatic risk in agriculture and insure more efficient crop production. Most of the irrigated acreage is in the western part of the subbasin and is located in the counties of Marshall, Polk, and Pennington. In 1975, these counties had a total of 8,300 irrigated acres. Substantial acreages between the city of Crookston and the Red River of the North have been determined

to be suitable for irrigation development through the construction of sprinkler systems supplied by either surface water or groundwater. Although permits for irrigation withdrawal have been obtained for some of this land, very few are being used.

The economy of the subbasin depends almost entirely on agriculture, and the success of agriculture is directly related to the timely occurrence and amount of rainfall during the growing season. In the years when rainfall is not sufficient, irrigation in the subbasin would increase crop yields and provide more profitable farm production; however, the potential for increased irrigation is unknown. Much of the soil is only moderately suitable for irrigation because of its poor drainage capability.

Wastewater Management

The Minnesota Pollution Control Agency (1975) identified 36 point source dischargers: 19 municipalities, eight industries, six municipal water treatment facilities, two municipal airports, and one major feedlot. Table 3 presents the problems and needs for these 37 dischargers. The data in this table indicate that excessive levels of BOD, TSS, and fecal coliforms frequently occur. The primary cause for these pollution problems is inadequate treatment facilities. High temperatures, which were in violation in 73 percent of the samples taken, were reported from the effluent of the Crookston Steam Power Plant. Inaccurate reporting is also a frequent problem.

Several small unsewered communities are located within the subbasin. Seepage from septic tanks within these communities could possibly be creating a pollution problem, such as fecal coliforms and other bacteriological pollutants (Minnesota Pollution Control Agency, 1975).

Hydropower

Three small hydropower units were built on the Red Lake River, but none of them is now in operation. A unit located at Crookston was retired when the wheel failed and repair was impossible. Two facilities located at Red Lake Falls were flooded, and repair has not been feasible because the river does not have a dependable flow. Hydro operation is difficult because drainage of sloughs and other holding areas during the 1950's

Table 3

TREATMENT PROBLEMS AND NEEDS OF POINT SOURCE DISCHARGERS IN THE RED LAKE RIVER SUBBASIN

Discharger	Receiving Water	Problems	Treatment Needs	Other Planning Considerations
Northome	Bartlett Lake which drains to Red Lake via the South Branch Battle River	No operating reports or effluent data	Improved treatment; phosphorus removal required	Population projected to increase; interim standards in permit; low on MNL
Kelliher	South Branch Battle River via a swamp and a ditch	Possible operational problems resulting in high TSS	Expected to be adequate	Population projected to decline
Blackduck	Blackduck Lake via Colburn Creek	Excessive levels of BOD, TSS and fecal coliforms	Improve treatment phosphorus removal eliminate by-pass	Population projected to decline
Blackduck Water Treatment Plan	Colburn Creek via storm sewer	No treatment	Provide treatment or connect to municipal	May connect to municipal if: execute contract 6/30/75; complete connection 6/30/76
Grygla	Mud River	Inadequate treatment	Stabilization ponds proposed	Construction will be funded by FHA and local funds. Will be removed from MNL
Grygla Cooperative Creamery Association	Mud River	Creamery has failed to submit effluent report citation	Improve treatment see narrative for compliance schedule	Effluent report delinquency may require citation
Thief River Falls Water Treatment Works	Red Lake River via a ditch	No treatment	Treatment facility has been proposed--see narrative for compliance schedule	
Thief River Falls	Red Lake River via Branch #1 and County Ditch #8	No apparent problems	Expected to be adequate	Population projected to increase
Thief River Falls Public Airport	County Ditch to Red Lake River	No reports available; nature of problems unknown	Expected be adequate for duration of plan	
St. Hilaire	Red Lake River	No apparent problems	Expected to be adequate for duration of plan	Population projected to increase to extent that increased capacity may be needed
Bagley	Clearwater River	No apparent problems	Expect to be adequate	Population projected to remain stable
Bagley Water Treatment Works	Clearwater River	No treatment	Treat wastes or connect to municipal system	Contract for connection option executed by 2/28/75 connection by 12/31/75
Gesell Concrete Products	Clearwater River via Janous Creek	No treatment	Treat effluent	--
Plummer	Clearwater River	Poor reporting; no other apparent problems	Adequate treatment	Stable population
Clearbrook	Silver Creek thence to the Lost River	Excessive levels of BOD, TSS and fecal coliforms	New facility or upgrading	Interim standard. until 5/31/77 low on MNL
Gonvick	Lost River	Excessive levels of BOD, TSS and fecal coliforms, broken chlorinator	Repair chlorinator; new facility or upgrading	Interim standards until 6/15/77
Oklee	Lost River	Inadequate treatment	New facility	Must apply for permit 180 days prior to discharge
			Treat effluent	--
Oklee Creamery Association	Lost River	Inadequate treatment	Facility should be adequate if properly maintained	--
Thunderbird Ranch Feedlot	Hill River via an unnamed ditch	Nature of problem unknown	New facility	Must apply for permit 180 days prior to discharge
Brooks	Hill River via an unnamed stream	Inadequate treatment	Treat effluent	--
Brooks Cheese Factory	Tributary of Hill River via a ditch	No treatment		

-continued-

Table 3 (Cont'd)

TREATMENT PROBLEMS AND NEEDS OF POINT SOURCE DISCHARGERS IN THE RED LAKE RIVER SUBBASIN

Discharger	Receiving Water	Problems	Treatment Needs	Other Planning Considerations
McIntosh	Poplar River	Inaccurate reporting: no apparent operational problems	Adequate treatment	Population projected to decrease
Fosston	Poplar River	Excessive levels of BOD, TSS and fecal coliforms	New facility or up-grading	Interim standards until 6/30/77; low on NH4
Fosston Water Treatment Works	Poplar River	No treatment	Treat wastes or connect to municipal system	Contract for connection option executed by 9/30/74 connection by 9/30/75
Erskine	Badger Lake via a ditch thence to Poplar Lake via Poplar Lake Ditch	Possible reporting and/ or operating problems	Phosphorus removal; no other apparent needs	Interim standards excluding phosphorus standard appear in permit
Red Lake Falls Water Treatment Works	Clearwater River	No treatment	Plans submitted to connect to municipal system connection by 7/1/75	—
Red Lake Falls Municipal Airport	Red Lake River	Nature of problems unknown	Not known	—
Red Lake Falls	Red Lake River	Plant is organically overloaded; BOD and fecal coliform levels are excessive	New facility or plant expansion	Municipal WTW Plans to connect to municipal system
Northern Minnesota Water Company	Red Lake River via a drain tile	Nature of problems unknown	Not known	—
Crookston Stream Plant of the Ottertail Power	Red Lake River	Temperature of effluent excessive; nature of other problems not known	Cool effluent; other needs not known	Plant plans to close in 1975 if done by 6/30/75, final standards do not apply
American Crystal Sugar, Crookston	Red Lake River	Nature of problem not known	Must treat effluent to meet final standards	Interim standards until 10/1/75
Crookston	Red Lake River	High influent BOD and TSS; poor reporting	Better reporting; may need improved treatment	Interim standards until 6/30/77
Fisher	Red Lake River	No apparent problems	No apparent needs	—
American Crystal Sugar, East Grand Forks	Red River of the North	Nature of problems not known	Not known	—
East Grand Forks Water Treatment Works	Red River of the North via Red Lake River	No treatment	Treat wastes or connect to municipal system	Contract for connection option executed by 3/31/75 connect by 6/30/76
East Grand Forks	Red River of the North	No apparent problems	Adequate treatment	Population projected to increase but facility operating at 1/2 capacity

Source: Minnesota Pollution Control Agency, 1975.

has resulted in spring floods, and the flow is insufficient from July until the next spring. The local power company has no plans to install more units on Red Lake River at this time. Hydropower could be developed in the subbasin if a control structure were built on Red Lake to raise the water level and if a series of dams and units were constructed between the lake and Crookston. However, such a project is considered economically infeasible by the power company.

Furthermore, hydropower development plans would entail negotiations with the Red Lake Reservation which has treaty rights to manage water in the Red Lakes.

Public Perception of Problems and Solutions

The public's perception of problems and solutions in the subbasin is adequately defined because the Corps of Engineers has held several public meetings in this area, and the subbasin has been organized as a watershed district. The primary documents for the identification of public perceptions are the Plan of Survey Interim Report on Red Lake River (1970), Red Lake River Feasibility Study (1971), Red Lake Watershed District Overall Plan (1972) and Annual Report (1978), and the 1979 Priorities Report of the Souris-Red-Rainy Regional Committee.

In March of 1964 at Crookston, approximately 150 people attended the first in a series of public meetings regarding development of a plan of improvement for the subbasin. In June of 1970, the Corps held a meeting with affected landowners to discuss a proposed plan and alternatives. In March of 1971, a midstudy public meeting was held in Red Lake Falls to exchange information on the water management problems in the subbasin and to discuss possible solutions. As a result, the Red Lake River Basin Planning Commission, representing a broad range of concerned local groups and state and other interests, was formed. Their charge was to further examine plan alternatives and to clarify issues so that a decision could be reached by the people on a plan that would best meet their needs and receive broad-based public support.

Subsequently, the planning commission met regularly, discussed varied aspects of local water resouce planning, and reviewed and discussed problems, needs, and alternative solutions. Results of an opinion questionnaire

given to commission members and advisors indicate that the local representatives feel there is a strong need for flood control for the urban areas of Crookston, Grand Forks, and East Grand Forks and the agricultural areas along the Red River. The most acceptable method of providing this flood protection was assumed to be upstream reservoir storage.

A public meeting in December 1975 was devoted primarily to receiving additional information from the public on the problems and needs in the Burnham Creek Watershed. Additional evidence for interest in flood control measures is contained in public hearings held in East Grand Forks in 1978 and 1979 before subcommittees of the Committee on Public Works and Transportation of the U.S. House of Representatives. From these documents, it is evident that residents of the Red River Basin consider flood control to be the primary water related need for the area and that they are interested in whatever solutions may be proposed by Federal, state, or local agencies.

Currently, studies are in progress for a flood control project in the Burnham Creek Watershed. In view of the strong support voiced by various agencies and local residents for a project addressing flooding on the Red Lake River, the Souris-Red-Rainy Regional Committee included a position statement in their June 1979 Priorities Report. The statement stresses the need for Federal and state attention towards the formulation of flood control measures along the Red Lake River.

IV. DESCRIPTION OF SUBBASIN RESOURCES

IV. DESCRIPTION OF SUBBASIN RESOURCES

This section of the report discusses the primary resource conditions within the subbasin that are water-related and that would be affected by a comprehensive water and related land resources plan centering on flood control measures.

Social Characteristics

Between 1940 and 1970, the population of the subbasin declined steadily primarily because of outmigration. The residents moved out of the subbasin to the large metropolitan areas because farm employment was rapidly decreasing, and employment opportunities in other sectors were lacking. Between 1970 and 1977, all of the counties within the subbasin increased in population, except Red Lake County. The northwestern part of the subbasin (Marshall County) experienced a natural increase (more births than deaths) in population and had a net out-migration rate of -0.7 percent. Koochiching County, which is in the extreme eastern part of the subbasin, also had a natural increase and an out-migration rate of -1.8 percent. Except for Red Lake County, the rest of the counties in the subbasin increased in population, primarily because of a net in-migration rate that averaged 8 percent. Red Lake County's population decrease was the result of out-migration (5.0 percent). The subbasin's total population increased by 10.6 percent, from 52,157 in 1970 to 57,672 in 1977.

A slight majority (52.9 percent) of the population resides in unincorporated areas. The largest towns in the subbasin are Thief River Falls (9,088), Crookston (8,432), Red Lake Falls (1,585), and Bagley (1,257). The population of Thief River Falls and Crookston increased by 5.5 percent and 1.4 percent, respectively, while Bagley decreased by 4.3 percent and Red Lake Falls decreased by 8.9 percent. None of the other towns in the subbasin have populations that exceed 800, and many of them have had increases in population. The population density for the subbasin increased from 8.7 persons per square mile to 9.7 persons per square mile between 1970 and 1977.

Communities in the subbasin are close knit, as can be seen from home ownership, length and county of residence, and county of employment. Ten counties are represented in the subbasin. Most of the residents

own their homes, ranging from 73.7 percent in Beltrami County to 82.6 percent in Itasca County. Census figures for 1970 indicate that from 59 percent (Clearwater County) to 70 percent (Marshall County) of the population occupied the same residence as in 1965. From 68 percent in Beltrami County to 86 percent in Itasca and Marshall counties resided in the same county during the five-year period. Most of the subbasin's population is employed in the county of residence, ranging from 74 percent in Polk County to 90.4 percent in Clearwater County.

The black minority population is too small to be identified; however, the Red Lake Indian Reservation, occupying 639 square miles, lies entirely within the subbasin. An estimated 3,000 persons reside on the reservation. The reservation is the only closed reservation in the Red River Basin and, as such, is exempt from all state and Federal taxes. The reservation is administered by the Red Lake Band of Chippewa Indians Tribal Council and the Bureau of Indian Affairs. Forest-related industries and commercial fishing are the primary sources of income since agriculture is limited by extensive areas of forest and peat bogs.

Economic Characteristics

Employment

Between 1940 and 1970, farm employment in the subbasin decreased because of farm consolidation and technological improvements. Although the other employment sectors experienced gains in employment, they were not sufficient to nullify agriculture's negative influence. As a result, a general decrease in employment occurred. Between 1970 and 1977, agricultural employment stabilized and then slowly increased, while other sectors (primarily trade and services) had moderate increases. Thus, total employment increased from 18,777 in 1970 to 23,069 in 1977, which was a 23 percent increase.

Agriculture is the largest employment sector in the subbasin, followed by trade and services. Manufacturing employment constitutes only a small portion of the total employment. Unemployment averages approximately eight percent between 1970 and 1977. Employment is high during spring

and summer planting and during fall harvesting activities. Employment decreases during the winter months.

Unemployment rates in the Red Lake Indian Reservation average approximately 50 percent. The major reason for the unemployment is the absence of employment opportunities in the reservation.

Income

Total personal income for the subbasin increased from $248 million to $445 million between 1969 and 1977 (as expressed in 1979 dollars). In the eastern half of the subbasin, farm income ranges from three percent to 30 percent of the total personal income, and livestock sales amount to about half of the farm income. In the western half of the subbasin, farm income is almost 60 percent of the total personal income, and cash grain sales amount to more than 70 percent of the total farm income.

Average per capita income during the same years increased from $4,760 to $7,709, which was slightly below the 1979 average income figure of $8,314 for the whole state. Although there has been an upward trend in both total personal and per capita income, fluctuating farm prices are the primary determinants of income changes from year to year. Also, severe flooding can cause sharp declines in income, as in 1975.

Business and Industrial Activity

Agriculture

The major industry in the subbasin is agriculture, which includes the production of crops, livestock, and forest products. Approximately 37 percent (or 1,413,696 acres) of the subbasin's land area is under cultivation, 31 percent is forest, and nine percent is pasture.

The major crops grown in the subbasin are identified in Table 4. Wheat is the leading crop, accounting for 34 percent of the harvested acreage. This is followed by barley, hay, and oats, which collectively amount to 47 percent of the harvested acres. A crop that has grown in importance over recent years is sunflowers, which account for nine percent of the total harvested acres in the subbasin. There are also minor acreages of corn, sugarbeets, potatoes, flax, soybeans, and rye. The production of wild rice is significant in the eastern portion of the subbasin.

Table 4

1978 CROP STATISTICS, RED LAKE RIVER SUBBASIN

Crop	Harvested Acres	Yield Per Acre	Total Production
Wheat	323,830	31.9 bushels	10,330,200
Barley	178,060	43.8 bushels	7,799,000
Hay	146,440	2.2 tons	322,200
Oats	113,890	51.4 bushels	5,854,000

Source: Gulf South Research Institute.

Although the amount of land under wild rice cultivation is a very small percentage (less than two percent) of the total acreage, production is expected to increase. The large volume of water needed for paddy rice is taken from ditches, creeks, and rivers during the spring high water and returned again during the low flow period before harvest. By holding excess water in rice paddies during the spring, some flooding may be controlled.

The western portion of the subbasin specializes in growing small grains, sugarbeets, potatoes, and sunflowers. Livestock production is very limited. The south and southeastern portions produce small grains, potatoes, hay, pasture crops, and wild rice. Livestock production is more prevalent in the north-central and northeastern parts of the subbasin, and the main cash grain crops are oats and barley.

Cropping patterns within the floodplain of the subbasin are similar to those throughout the subbasin.

Manufacturing

There are 72 manufacturing establishments in the subbasin, most of which are connected with agriculture, lumbering, or the dairy industry. More than 50 percent of the manufacturers are located in the cities of Crookston and Thief River Falls. In recent years manufacturing employment in the western portion of the subbasin has increased moderately.

The larger cities (Thief River Falls, Crookston, Bagley, and Red Lake Falls) are located here as well as the majority of the manufacturers. The largest employers in the subbasin are American Crystal Sugar (over 500) and J.R. Simplot Company (250-500) in Crookston and Arctic Enterprises (over 1,000) in Thief River Falls. Table 5 presents the estimated manufacturing employment by two-digit Standard Industrial Classification (SIC) code.

Table 5

MANUFACTURING ESTABLISHMENTS, RED LAKE RIVER SUBBASIN

SIC	Description	Estimated Employment
20	Food and Kindred Products	1,500
24	Lumber and Wood Products	350
25	Furniture and Fixtures	50
27	Printing and Publishing	100
28	Chemicals and Allied Products	75
32	Stone, Clay, and Glass Products	125
35	Machinery, except Electrical	400
37	Transportation Equipment	1,500
TOTAL		4,100

Source: 1979-80 Minnesota Directory of Manufacturers.

Trade

In 1977, total trade receipts for the subbasin exceeded $370 million (expressed in 1979 dollars). More than 51 percent (or $189 million) of the receipts were retail trade. Wholesale trade and selected service receipts were $181.8 million and $22.2 million, respectively, in 1977.

Transportation Network

The subbasin is crossed from north to south by Federal Highways 75 (through Crookston), 59 (through Thief River Falls, Plummer, and Brooks), and 71 (through Funkley, Northome, and Blackduck), and from east to west by Federal Highway 2, which passes through Crookston, Mentor, Erskine, McIntosh, Lengby, and Bagley. There are also numerous state and county

roads that provide access from the more rural areas to the major arteries, which travel to urban areas such as Grand Forks, Duluth, Fargo-Moorhead, and Minneapolis-St. Paul.

The subbasin is also crossed by two rail lines. The Burlington-Northern parallels U.S. Highway 2 east to west, and the Soo Line Railroad extends from southwest to northeast adjacent to U.S. Highway 71 in the central part of the subbasin. There is a large regional airport at Thief River Falls, and small municipal airports with limited facilities are located in Crookston, Erskine, Red Lake Falls, and Northome.

Land Use

The subbasin contains more forest acreage than any other subbasin in the Red River Basin. The land in forest amounts to 31.7 percent of the subbasin. Water and marsh areas are significant, accounting for nine percent and 12 percent, respectively, of the total land area. Because of the large land acreages in other categories, cultivated crops occupy only 37 percent of the land area, and pasture amounts to nine percent. Urban development is minimal. The largest acreage of cropland is in the western portion of the subbasin, most of the pasture land is found in the central area, and the largest forest acreage occupies the northeastern part of the subbasin.

Land use in the floodplain does not differ significantly from land use throughout the subbasin. The floodplain is primarily under cultivation in the western and south-central parts of the subbasin. Forest acreages are significant in the northeastern part of the subbasin and along the rivers.

Environmental Characteristics

Climate

Weather observations can be obtained from U.S. Weather Bureau Stations at three locations in the subbasin: Crookston, Red Lake Falls, and Thief River Falls. Temperature variations within the subbasin are extreme, ranging from an all-time low of -50°F to a high of 102°F. The average annual temperatures range from 29.2°F to 49.5°F (recorded at Red Lake,

Minnesota). The short growing season, from June 5 to October 27, has limited agriculture in the subbasin to small grains and forage crops. Average precipitation varies from 20 inches per year on the western edge to 23 inches per year on the eastern edge of the subbasin. Most of the precipitation occurs during June, July, and August, with an average of 10 inches per year falling during this period. Normal snowfall is from 40 to 50 inches per year. Most of the precipitation is lost through evapotranspiration, which averages 19.4 inches per year. The remaining runoff of 2.6 inches per year occurs primarily in the month of April during spring snowmelt.

Geology

The subbasin lies within the Western Lake Section in the Central Lowland Province of the Interior Plains. Bedrock is predominantly undifferentiated Precambrian igneous and metamorphic rock overlain by undifferentiated Cretaceous deposits of sandstone and interbedded shale in the western portion of the subbasin. Glacial deposits of clay, till, and sands and gravel overlie bedrock and range from about one foot thick near Kelliher to over 500 feet thick near Bagley. The largest concentration of swamp deposits (consisting of peat and muck) found in the Red River Basin is located in the northeastern section of the subbasin.

Landscape features characteristic of glacial geology, including level lands, beach ridges, lakes, and swamps, are each represented in the subbasin and are distributed in fairly distinct bands trending north to south across the region. The Upper and Lower Red Lakes are major features of the subbasin. The two lakes are remnants of glacial Lake Agassiz and together comprise the largest lake area wholly contained in Minnesota.

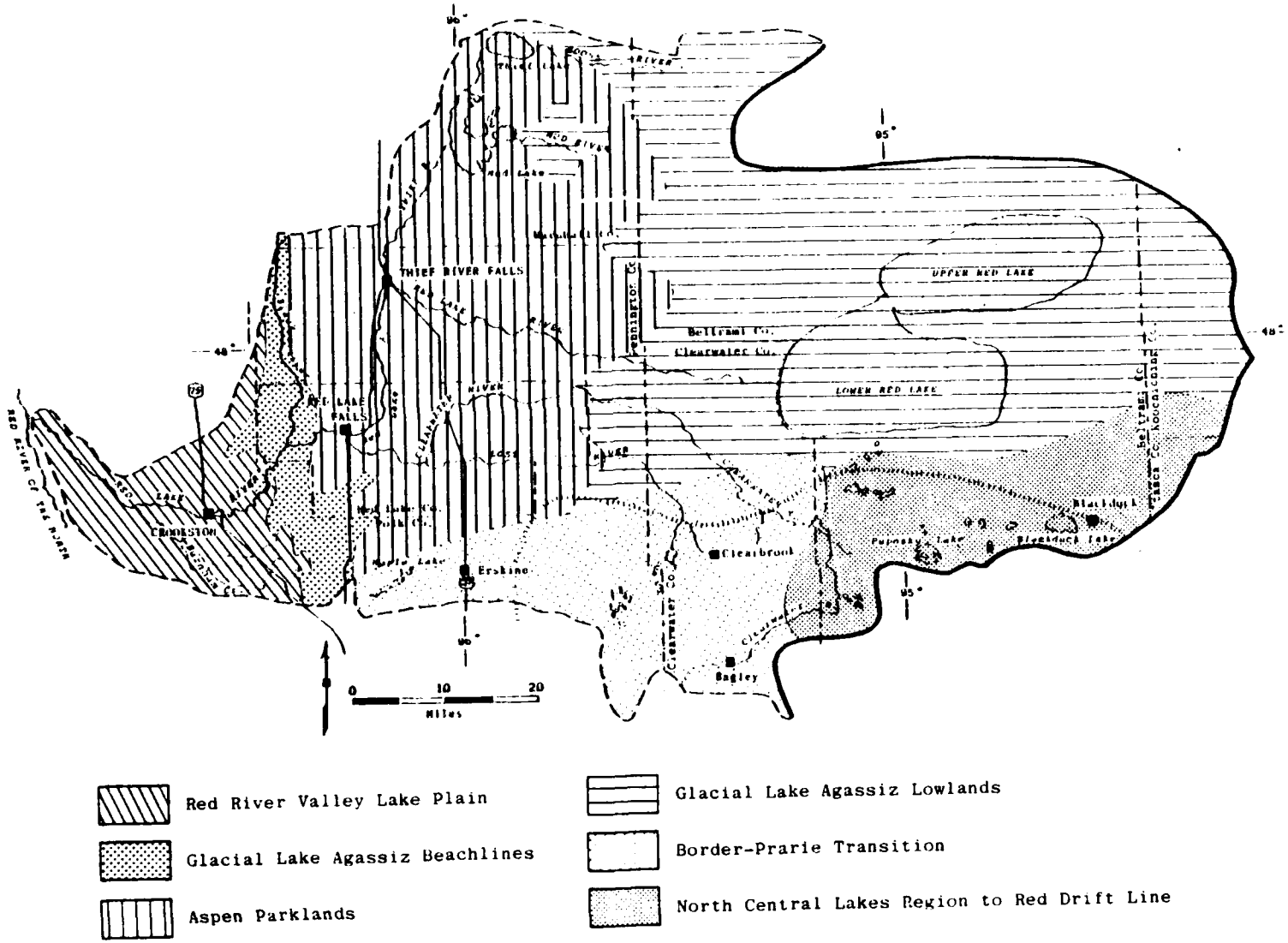
Biology

The principal forest types of the area are the elm-ash-cottonwood, aspen-birch, spruce-fir, pine, maple-basswood, and unproductive forest land associations. The elm-ash-cottonwood type occurs along the Red Lake River and tributaries such as the Thief River and Clearwater River and as scattered woodlots (some of relatively large size) through Marshall, Pennington, Red Lake, and Polk counties. Characteristic plants in this

community include American elm, green ash, cottonwood, willows, basswood, hackberry, birch, boxelder, bur oak, prickly ash, gooseberry, nettles, and various grasses and vines. The aspen-birch type is found throughout the four counties mentioned above, but reaches its greatest development on the western, southern, and eastern sides of Upper and Lower Red Lake. Common plant taxa consist of aspen, paper birch, and red-osier dogwood. The spruce-fir type is located mainly along the northern and eastern sides of Upper Red Lake, with other tracts scattered around Lower Red Lake, Mud Lake, and to the east of Thief Lake. This type is part of the Great Lakes Spruce-Fir Forest and contains mainly white spruce and balsam fir. The pine type is situated south of Lower Red Lake and between Upper and Lower Red Lakes near Ponemah and Shotley. Conifers occurring in this community include red pine, white pine, jack pine, and white spruce, with an interspersion of hardwoods such as birch, aspen, and bur oak. The maple-basswood type is infrequent in the subbasin and is located primarily east of Trail, southwest of Clearbrook, and northwest of Island Lake. Major species are composed of sugar and red maple, basswood, and yellow birch or upland elm. The unproductive forest land type refers to those areas inhabited by poorly drained swamp or lowland conifers. They are situated north of Upper Red Lake, east of the Red Lakes region, east of the Clearwater River near Berner, and northeast of Gatzke. Typical species include black spruce, tamarack, and arbovitae. These trees also occur in poorly drained sections of the spruce-fir and pine types (Minnesota Water Resources Board, 1972; North Central Forest Experiment Station and Minnesota State Planning Agency, no date; Elwell et al., 1973; U.S. Army Corps of Engineers, 1975, 1977).

Some bluestem prairie can be found in the subbasin along the Red Lake River in those areas that have not been farmed. Dominant grasses include big and little bluestem, switchgrass, and Indian grass (U.S. Army Corps of Engineers, 1977).

Six wetland zones are contained within the limits of the subbasin: Red River Valley Lake Plain, Glacial Lake Agassiz Beachlines, Aspen Parklands, Glacial Lake Agassiz Lowlands, Border-Prairie Transition, and North Central Lakes Region to Red Drift Line (Figure III). The Lake Plain zone is



Source: Mann (1970).

Figure III. MAJOR WETLAND ZONES WITHIN THE RED LAKE RIVER SUBBASIN

found in the flat river valley floor in the western part of the subbasin where most wetlands and native prairie have been developed for agricultural uses. The Beachline zone is found immediately east of the lake plain and once contained numerous shallow wetlands. Some long, narrow marshes probably remain in the areas that have been left relatively undisturbed. The Aspen Parkland zone forms the dynamic transitional area between grassland and coniferous formations and is composed of potholes and shallow marshes interspersed with aspen groves. The Glacial Lowlands zone is characterized by extensive peatlands and stretches of sandy mineral soils. North and west of Upper Red Lake, these lowlands comprise an extensive, pristine wetland of tree-covered, raised bogs and large expanses of sedge mats and emergent aquatics. This is a very unique and primitive area. The Border-Prairie Transition zone contains numerous wetlands of various types in the areas where agricultural development is limited. The North Central Lakes Region to Red Drift Line zone is found south of Lower Red Lake, contains many lakes, ponds, and bogs, and is heavily forested with conifers and mixed hardwoods. Type 3 or 4 marshes may reach densities of approximately nine per square mile and are frequently found in combination with shrub swamps (Mann, 1979). The Minnesota Water Resources Board (1972) indicated that the largest expanse of peat in Minnesota is found in the eastern part of the Red Lake Watershed District (which closely approximates the boundaries of the subbasin) and that a vast deposit of sphagnum moss is found north of Upper Red Lake in townships 155 and 156 North, ranges 31 and 32 West, in Beltrami County.

The important wildlife habitats of the subbasin include the remaining remnants of native prairie, wetlands, and woodlands. Agricultural development has reduced the areal extent of much of these habitats, particularly in the western portion, with its flatter lands and better drained soils. The grasslands are important habitats for certain vertebrate and invertebrate organisms and form a dynamic and diverse ecosystem when found in combination with wetlands. The wetlands, composed of such types as marshes, shrub swamps, and bogs, provide significant breeding, nesting, rearing, feeding, and resting habitats for a number of resident and migratory wildlife, as well as spawning and nursery areas for aquatic biota. The woodlands

of the subbasin afford significant feeding, resting, breeding, and nesting habitats for a greater variety of wildlife than any other major habitat type in the subbasin. Additionally, the floodplain woodlands furnish an important travel and migration corridor through the disturbed areas of the western part. These need to be protected, conserved, and enhanced wherever possible (U.S. Fish and Wildlife Service, 1980).

The most abundant big-game animal in the subbasin is the white-tailed deer. During the 1978 hunting season, the following harvests were reported from the counties included by the subbasin's limits: Marshall--778; Beltrami--1,794; Koochiching--1,405; Itasca--3,703; Clearwater--764; Pennington--122; Red Lake--99; and Polk--463. Moose are also common, and some black bear occur, as is evidenced by the following 1978 harvest figures: Beltrami--22; Clearwater--2; Koochiching--88, and Itasca--154. Typical furbearers include the raccoon, mink, beaver, red fox, and muskrat. Upland game birds and small game mammals consist of the gray squirrel, jackrabbit, ruffed grouse, sharp-tailed grouse (<0.1-6 adult males/square mile), Hungarian partridge (<5-20/100 miles), and woodcock (Mann, 1979; U.S. Fish and Wildlife Service, 1980).

Waterfowl production in the wetlands is important, with utilization more significant in types other than Type 8-bogs. Common breeding waterfowl include the mallard, wood duck, and blue-winged teal. The subbasin includes three Minnesota Department of Natural Resources breeding bird regions: 1N, 1E, 2W. A total of 101, 103, and 99 breeding birds, respectively, have been reported from each of these regions. The breeding birds include non-native pest birds, non-native game birds, native game birds, and native nongame birds. Typical nongame breeding birds in the subbasin include the robin, veery, red-eyed vireo, and yellowthroat.

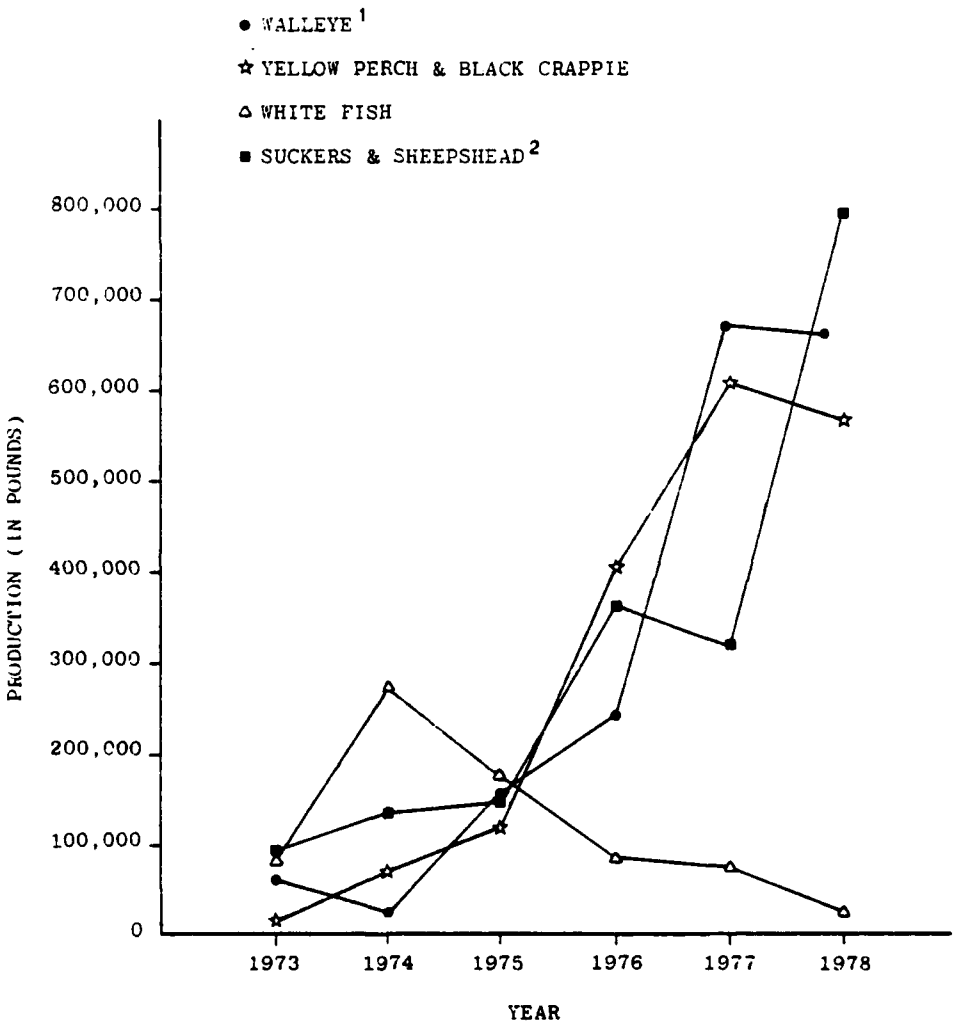
Approximately 42 species of nongame mammals have been identified from the counties of the subbasin. Common species include the red squirrel, masked shrew, white-footed mouse, thirteen-lined ground squirrel, and Gapper's red-backed vole. About 22 species of amphibians and reptiles occur in the subbasin, with typical species composed of the wood frog, northern leopard frog, eastern tiger salamander, and common garter snake (Henderson, 1979; Henderson and Reitter, 1979).

The Red Lake River has been designated by the Minnesota Department of Natural Resources as a state canoeing and boating river (Miles and Yaeger, 1979). Because the river supports a very good population of sport fishes, the Department of Natural Resources has also classified it as a warmwater gamefish (Class II) stream. Common game fish of Red Lake River include walleye, channel catfish, yellow perch, northern pike, and rock bass. Walleye fishing of Red Lake River is considered excellent. Freshwater drums, white suckers, silver and northern redhorses, common shiners, spot-tailed shiners, and quillbacks are common rough or forage fishes that inhabit the Red Lake River (Elwell et al., 1973; U.S. Fish and Wildlife Service, 1979). Ten trout streams are located within the subbasin: Hoover Creek, Battle River, Meadow Creek, Mud River, Clearwater River, O'Brien Creek, Spring Creek, and Spring Lake Creek in Beltrami County; Lost River and a portion of Hoover Creek in Koochiching County; and Lengby Creek in Polk County (Miles and Yaeger, 1979; U.S. Fish and Wildlife Service, 1979). Fishes common to the Upper and Lower Red Lakes are the walleye, northern pike, yellow perch, and whitefish (U.S. Army Corps of Engineers, 1975). Maas (1976, 1977, 1978) reports that the commercial fishery on Red Lakes is good for walleye and yellow perch. Figure IV shows the production of some of the important species commercially processed from the Red Lakes.

Common aquatic insects of the Red Lakes and Red Lake River include may flies, dragon flies, damsel flies, stoneflies, caddisflies, midges, riffle beetles, and crane flies. Elwell et al. (1970) reported the water boatman (Dasycorixa hybrida), which is considered rare (Pennak, 1953), from 50 percent of their sampling stations. Other common benthic invertebrates include crustaceans and mollusks such as scuds (Gammaridae), water fleas, crayfish, and snails (Amnicola and Helisoma, especially). Cvancara (1970) reported live representatives for thirteen species of mussels from Red Lake River. Annelids and flatworms have also been reported from the Red Lakes and Red Lake River (Elwell et al., 1973; U.S. Army Corps of Engineers, 1975).

In addition to the diverse faunal population, many species of plankton are also represented within the subbasin. Common diatoms include Amphora sp.,

PRODUCTION OF IMPORTANT FISHES FROM THE RED LAKES, 1973-1978.



[1] All Walleye processed after July, 1975 were graded no.1 (no culls).

[2] Includes all fish marketed as animal food.

Sources: Annual Project Report, 1978, Fishery Management Program; Red Lake Indian Reservation; Charles L. Mass for the U.S. Fish and Wildlife Service, Fishery Management Office, Bemidji, Minnesota.

Figure IV. PRODUCTION OF IMPORTANT COMMERCIAL FISHES FROM THE RED LAKES, 1973-1978

Cocconeis sp., Navicula spp., Melosira spp., Tabellaria fenestrata, and Nitzchia spp. The density of the periphytic population decreases with downstream distance, possibly because of increased turbidity and lack of favorable substrates. Microcystis sp. and Pediastrum sp. are blue-green and green algae, respectively, that are encountered in the Red Lakes. Red Lake River has an abundance of species of algae such as Anabena sp., Oocystis spp., Pediastrum spp., and Scenedesmus spp. This diversity of plankton and benthic communities is a good indicator of the high productivity of the streams and lakes within the subbasin.

Vascular plants such as pondweeds, sedges, rushes, and cattails provide the fishes and other aquatic fauna with a variety of habitats. These plants are found in the littoral zone of the lakes and potholes and along the point bars of the streams.

Table 6 lists the game and fish lake resources, by lake type, of the counties included in the subbasin. As was mentioned above, all of Red Lake County and only portions of the other counties are located within the subbasin.

Water supply

Groundwater aquifers in the glacial drift and underlying bedrock are an important source of water supply for small communities, farms, and ranches. This water is usually of good quality and suitable for domestic and livestock needs. In the eastern two-thirds of the subbasin, adequate water can be obtained from wells less than 150 feet deep. In the western part, it is necessary to drill through 50 to 100 feet of glacial lake sediments into the glacial till. The cities of Red Lake Falls, Bagley, and McIntosh use approximately 51,100,000 gallons, 32,850,000 gallons, and 47,450,000 gallons, respectively, per year according to 1978 figures of the Minnesota Department of Health. Red Lake Falls has three deep wells and uses the Red Lake River as a backup source. Local officials say that one more well is in the planning stages, since one of the wells is experiencing decreased output.

The large municipal supplies are obtained from surface water. Thief River Falls and Crookston obtain their water from the Red Lake River. The Minnesota Department of Health reports an estimated annual usage

Table 6

FISH AND GAME LAKE RESOURCES, BY LAKE TYPE, IN THE COUNTIES INCLUDED IN THE RED LAKE RIVER SUBBASIN

Type	County: Beltrami		Clearwater		Itasca		Kanchiching		Mahnomen		Marshall		Pennington		Polk		Red Lake	
	Number	Acres	Number	Acres	Number	Acres	Number	Acres	Number	Acres	Number	Acres	Number	Acres	Number	Acres	Number	Acres
Dry Lake Basins[1]	1	90	1	24	2	363	0	0	4	262	0	0	0	0	5	143	0	0
Game Lakes[2]	64	5,660	47	7,394	81	7,946	7	664	188	7,126	2	30,130	1	35	227	7,336	2	68
Marginal Lakes[3]	25	4,373	35	2,110	171	12,772	6	8,019	57	5,615	0	0	0	0	87	8,919	0	0
Fish and Game Lakes[4]	0	0	0	0	9	3,300	0	0	0	0	0	0	0	0	0	0	0	0
Fish Lakes[5]	103	--	37	--	412	--	8	--	10	--	0	0	0	0	5	--	0	0
Unclassified Lakes[6]	40	5,086	28	3,601	207	19,474	4	244	5	1,466	0	0	0	0	5	600	0	0
Centrarchid Lakes[7]	32	6,837	7	2,290	134	27,472	1	37	2	1,520	0	0	0	0	0	0	0	0
Walleye Lakes[8]	17	349,460	0	0	37	72,648	2	181	2	1,567	0	0	0	0	0	0	0	0
Trout Lakes[9]	2	48	0	0	11	1,097	0	0	0	0	0	0	0	0	0	0	0	0

[1]Dry lakes as reported here include those basins that do not have standing water throughout the year. This includes drained lake basins, dry basins with emergent vegetation such as cattails, and shrub swamps.

[2]Game lakes are those lakes shallower than six feet which ordinarily contain water throughout the years. They are ordinarily designated as being Type III or Type IV marshes.

[3]Marginal lakes are those that range from six to 20 feet deep, winterkill, and frequently have rough fish populations. Lakes with inlets are most likely to have rough fish populations.

[4]Fish and game lakes are defined as lakes in which both the game and fish resources are of major importance. These are lakes with several distinct connected basins, some river lakes, impoundments (especially the navigation pools on the Mississippi River), and the northern pike--wild rice--waterfowl lakes.

[5]Fish lakes are those that do not winterkill and have maximum depths that are ordinarily more than 20 feet and average depths that are 10 feet or more. Some soft water lakes, however, have average depths less than 10 feet and do not winterkill, and some fertile shallow lakes have inflows of water that add sufficient oxygen to prevent winterkills.

[6]Unclassified fish lakes are those where sufficient information is available to determine that they do not winterkill and are definitely fish lakes, but data available does not justify further classification. This category also includes a few lakes that do not readily fall into the remaining categories. For example, rough fish lakes that do not winterkill.

[7]Centrarchid lakes are those having fish populations that are primarily composed of bluegills, pumpkinseed, crappies, rock bass, largemouth bass, and/or smallmouth bass. These lakes frequently have good populations of northern pike. Some of these lakes contain populations of walleye that are either artificially maintained or are a natural population that is a small fraction of the total fish population. In the northeastern part of the state smallmouth bass and rock bass tend to be the most important segments of a centrarchid population in a lake. Crappies and green sunfish are the centrarchids that occur most commonly in very eutrophic southern lakes.

[8]Walleye lakes are those having walleyes, yellow perch, common suckers, northern pike, and frequently tullibee as the main constituents of the fish population. Sometimes these lakes have fair sized populations of centrarchids, but they tend to be restricted to protected areas such as shallower weedy bays.

[9]Trout lakes are those containing known populations of trout, either naturally or maintained by stocking.

Source: Peterson, 1971.

of 365,000,000 gallons for both Thief River Falls and Crookston. Crookston has a large sugarbeet industry and a large fertilizer industry that use a substantial amount of water from the Red Lake River. The city of Crookston would like to convert to deep wells according to local officials, but action is pending a court decision on location of the wells.

Water Quality

The waters within the subbasin are used for a variety of reasons such as propagation of fish and wildlife, all types of agricultural purposes, industrial uses, drinking water, and aesthetics. All of the major streams of the subbasin have been classified by the Minnesota Pollution Control Agency (1975) as Effluent Limited, which means that significant reaches have a sufficient flow at all times to assimilate discharge effluents from secondary (or best practicable) treatment facilities.

Table 7 presents water quality data from three monitoring stations on the Red Lake River. Turbidity and TSS are the physical parameters that pose problems. Turbidity levels were in violation of the standards at least 33 percent of the time, while TSS levels often became quite high. Natural causes or agriculture-related erosion could create these problems. Oil and grease sometimes reached the maximum limitations, which indicates that at least one point source is not in compliance with effluent standards. Fecal coliforms were in violation of the standards 40-50 percent of the time at all three stations, which degrades the waters for recreational and drinking uses. Point sources (inadequately treated sewage) are the most probable cause of these violations, since agricultural activities are not as extensive in this subbasin as elsewhere in the state (Minnesota Pollution Control Agency, 1975).

Table 8 presents the water quality data from nine communities that use groundwater sources for their municipal supplies. Hardness was high in every sample taken. Iron concentrations also frequently violated the EPA's (1976) standard for domestic supplies of 0.3 mg/l. Sulfates and dissolved solids sometimes reached high levels, but were never reported over the standards (Bidwell et al., 1970).

AT GENTILLY, FISHER AND EAST GRAND FORKS

Description	Flow (cfs)	Temperature (°F)		D.O. (mg/l)		BOD_5 (mg/l)		NH_3 (mg/l)		Fecal Coliforms (MPN/100 ml)		TDS (mg/l)		pH	
Water Quality Standards in this Segment		5° Change 28-86° Max 2C-30° Max.		2B* [illegible] times 2C** 5 other times		--		2B-1.0 2C-1.5		200		[illegible]		6.5-9.0	
Monitoring Stations	Average 7-Day 10-Year Low	Average Maximum	Percent of Violation	Average Minimum	Percent of Violation	Average Maximum	Percent of Violation	Average Maximum	Percent of Violation	Average Maximum	Percent of Violation	Average Maximum	Percent of Violation	Average Range	Percent of Violation
1. RED LAKE RIVER - RL-56 Bridge CSAH-4 nr. Gentilly 17 reports 1961-65	--	[illegible] [illegible]	0	9.8 9	[illegible]	3.6 6.4	[illegible]	0.08 0.28	0	[illegible] [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2. RED LAKE RIVER - RL-23 Bridge on CSAH-12 nr. Fisher 19 reports 1961-65	--	[illegible] 89	0	[illegible] [illegible]	[illegible]	[illegible] 10.0	[illegible]	[illegible] 0.26	0	[illegible] [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1. RED LAKE RIVER - RL-3 E. Grand Forks 48 Reports 1970-74	--	[illegible] 81	0	[illegible] [illegible]	0	3.0 23.0	[illegible]	0.14 0.46	0	552 3500	50	[illegible]	[illegible]	[illegible]	[illegible]

Source: Minnesota Pollution Control Agency, 1975.

GENTILLY, FISHER AND EAST GRAND FORKS

[illegible] (mg/l)	Fe [illegible] (MPN/100 ml)	TC [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	TSS (mg/l)
2B-1.0												
2C-1.5	[illegible]											

Average	Average	Average	Average	Average	Average	Average	Average	Average	Average	Average
Maximum	Percent of Violation	Maximum	Percent of Violation	Maximum	Percent of Violation	Range	Maximum	Percent of Violation	Maximum	Percent of Violation	Maximum	Percent of Violation	Maximum	Percent of Violation	Maximum	Percent of Violation
0.08		422											0.35		45	
0.28		1300	40										2.5		920	
0.09		3.65											0.20		75	
0.26	0	25,000	50										0.52		260	
0.16		552							0.5		0.34		0.17		37	
0.66	0	3500	50						0.5		1.0	0	0.57		220	

Table 8

GROUNDWATER QUALITY DATA FROM SEVERAL COMMUNITIES
WITHIN THE RED LAKE RIVER SUBBASIN

Community	Well Depth (ft.)	Total Dissolved Solids (mg/l)	Hardness (mg/l)	Iron (mg/l)	Sulfate (mg/l)
Bagley	180	409	360	1.3	0.5
Blackduck					
Well #2	124	--	370	0.36	0
Well #3	130	--	350	3.4	1.3
Erskine	94	310	275	1.7	9.0
Fisher	140	--	210	1.3	150
Fosston	125	--	380	1.4	42
Kelliher	184	340	284	0.4	10
Oklee	268	--	260	4.0	95
Plummer	220	--	370	1.1	200
Red Lake Falls	146	--	490	1.7	130
St. Hilaire	129	694	440	0.31	196

Source: Bidwell, et al., 1970.

Aesthetics

Most of the Red River Basin lacks a variety of landscapes. The Red Lake River Subbasin, however, borders the Minnesota Forest Region and is characterized by many large tracts of forest, large and small lakes, and marsh areas. Areas of particular aesthetic appeal include Agassiz National Wildlife Refuge, seven state forests, Upper and Lower Red Lakes, and the natural wooded corridor along Red Lake River, which is classified as a state canoeing and boating river.

These sites contain a variety of forest and lake areas that prov contrast to the level terrain in large portions of the Red River Basin and provide residents with significant recreational opportunities. In addition, the Old Crossing Treaty Wayside (1,200 acres) commemorates the site at which the Red Lake and Pembina bands of the Chippewa Indians ceded, by treaty, over five million acres to the United States in 1863.

The Wayside and Red Lake Indian Reservation attract many tourists to the subbasin each year.

Cultural Elements

The subbasin has played a significant role in the prehistory and history of the State of Minnesota. Twelve archeological sites have been recorded within the subbasin to date. Of these, seven have Woodland cultural components. One of these Woodland sites is representative of a late prehistoric culture called the Arvilla Complex. Arvilla burial mound sites, with few exceptions, are located on glacial strandlines in the Red River Valley and throughout central Minnesota (Wedel, 1961:226; Johnson, 1973:3, 58). There is no evidence at this time to indicate that habitation sites (i.e., villages) are associated with the Arvilla mound complexes (Johnson, 1973:5, 60).

A second, late prehistoric culture called the Blackduck focus is also well-represented in the subbasin, The Blackduck focus, like the Arvilla complex, is characterized by burial mounds and associated grave goods that are similar to those of Arvilla. The Blackduck focus is tentatively associated with the Assiniboine Indians, who migrated from the Minnesota woodlands northward and westward into the prairie-park belt and eventually onto the northern plains (Wedel, 1961:224-229; Hewes, 1948:50; Strong, 1940:358). The migrations of Siouan peoples from the northeastern periphery of Minnesota may be correlated with the diffusion of mound-building onto the eastern plains of North Dakota (Wedel, 1961:224).

Not much systematic archeological field work has been conducted in the subbasin, with the exception of a survey along the proposed Red Lake River Reservoir (Streiff and Roney, 1973). Most of the sites located in this survey were surface artifact scatters with no significant concentrations of cultural materials. However, the known or expected association of cultural resources with major streams highlights the importance of on-site surveys to adequately assess the potential impacts of proposed construction.

European explorers and fur traders played prominent roles in the region's early history. For instance, an Italian traveler named Giacomo Constantino Beltrami explored the Red Lake River country in 1823. He erroneously concluded that Red Lake was the source of both the Mississippi

River and the Red River. Earlier explorers had mistakenly designated Turtle Lake (1798) as well as Leech and Cass lakes (1806) as the source of the Mississippi River (Blegen, 1963:90). Although these lakes are outside of the study area, the search for the source of the Mississippi River contributed significantly to the exploration of the subbasin.

Related members of the Siouan language family, including the Assiniboine Indians, dominated the Red Lake region in the 1700's. It was the Chippewa Indians, however, who controlled the subbasin during the most intense period of Euro-American colonization. In treaties of 1855 and 1866, the Chippewa ceded most of their tribal lands, which today comprise the subbasin (Blegen, 1963:172-173). These Chippewa land cessions opened northwestern Minnesota to settlement by lumbermen, miners, and farmers. Today, a significant portion of the subbasin's population is of German and Norwegian descent. Sixteen historical sites have been recorded within the subbasin. Of these, none are listed on the National Register of Historic Places. One is nominated to the National Register.

Recreation Resources

Recreational resources are abundant within the subbasin. The major recreational areas include Agassiz National Wildlife Refuge (61,487 acres) in Marshall County, a small portion of Chippewa National Forest in Beltrami County, and seven state forests that are wholly or partially located within the subbasin, including Beltrami Island (505,954 acres), Mississippi Headwaters (9,170 acres), Red Lake (59,257 acres), Pine Island (641,136 acres), Big Fork (45,293 acres), Blackduck (41,375 acres), and Buena Vista (18,488 acres). The location of these sites and other recreational areas larger than 15 acres is depicted in Figure V, and an inventory of facilities is included in Appendix B of this report.

Hunting is an important recreational activity in the subbasin, as evidenced by a total of 61 wildlife management areas that comprise 263,746 acres. Moose, elk, deer, partridge, geese, and ducks are present within the area. Furbearing animals include muskrat, mink, beaver, raccoon, and fox. In addition, there are 18 waterfowl production areas open to the public for hunting and other wildlife-oriented forms of recreation.

Upper and Lower Red Lakes are remnants of Glacial Lake Agassiz and together comprise the largest lake area (290,800 acres) wholly contained

EXISTING WILDLIFE AREAS

1 Thief Lake
2 Whiteford
3 Mudlac
4 East Valley
5 Grygla
6 Northwood
7 Eckvoll
8 Elm
9 Agder
10 Espelie
11 Sem
12 Carmelee
13 RC-2
14 RC-1
15 Red Lake
16 Sanders
17 Higinbotham
18 Pembina
19 Moran
20 Red Lake Falls
21 Gervais
22 Emardville
23 Oklee
24 Stipa
25 Marcoux
26 Brooks
27 Lessor
28 Gully
29 Le Blanc
30 Hangaard
31 Kertsonville
32 Tympanuchus
33 Foxboro
34 Dugdale
35 Trail
36 Shypoke
37 Tilden
38 Erskine
39 Bee
40 Maple Meadows
41 Dorr
42 Kaakaik
43 Polk
44 Enerson
45 Hill River
46 Brandsvolvo
47 Mac Meadow
48 Mulejohn
49 Sagaiian
50 Lengby
51 Little Pine
52 Shotley
53 Shooks
54 Clearwater-10
55 Clearwater-9
56 Clearwater-11
57 Clearwater-8
58 Old Red Lake Trail

EXISTING RECREATION AREAS

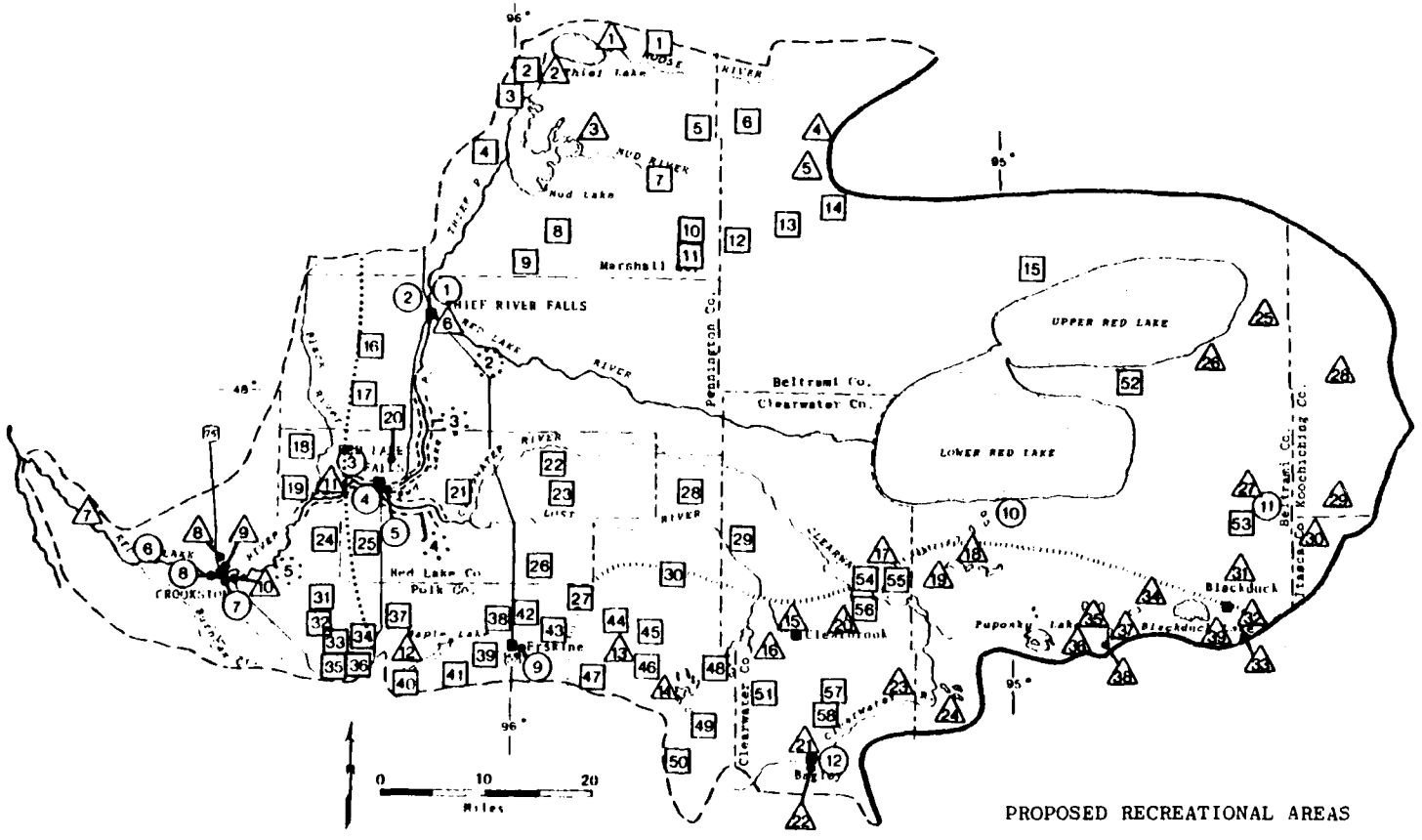
1 Odin Arron Hunting Camp
2 Melby Hunting Camp
3 Agassiz National Wildlife Refuge
4 Beltrami Island State Forest
5 Goodridge School Forest
6 Sportsman Park
7 University of Minnesota Tech Camp
8 Central Municipal Park
9 Castle Municipal Park
10 Highland Municipal Park
11 Old Crossing Treaty Way
12 Polk County Park
13 Hill River Public Access
14 Tilberg County Park Access
15 Clearbrook School Forest
16 Sportsman's Lodge Resort
17 Bagley Lake Public Access
18 Balm Lake Resort
19 Frontier Resort
20 Folk Lake Public Access
21 Bagley City Park and Ac s
22 Bagley School Forest
23 Clearwater County Memorial Forest
24 Mississippi Headwaters State Forest
25 Spruce Resort
26 Kansas City Resort
27 Red Lake State Forest
28 Pine Island State Forest
29 Northome High School Forest
30 Big Fork State Forest
31 Blackduck State Forest
32 Pine Tree Park
33 Chippewa National Forest
34 Cedar Rapids Lodge Resort
35 Bellon's Resort
36 Buena Vista State Forest
37 A Gaming Resort
38 Hendrick's Haven Resort
39 Tomahawk Lodge Resort

OTHER EXISTING RECREATION AREAS

1 Thief River Falls Golf Course
2 TRF Archery Club
3 Timberlane Ski Trail
4 Red Lake County Fairgrounds
5 Oak Knolls Golf Course
6 Fisher's Landing
7 Elk's Country Club
8 Highland Middle School Athletic Field
9 Win-E-Mac Golf Course
10 Red Lake School Athletic Field
11 Kelliher School Forest Athletic Field
12 Bagley Country Club

Sources: Minnesota Department of Natural Resources; Bureau of Planning, Northwest Regional Development Commission.

Figure V. RECREATIONAL RESOURCES



PROPOSED RECREATIONAL AREAS

- Pembina Trail
- (2) Tamarac Swamp
- (3) Red Lake River Canoe Route
- (4) Clearwater River Canoe Route
- (5) Natural Prarie Chicken Habitat

Sources: Minnesota Department of Natural Resources; Bureau of Planning, Northwest Regional Development Commission.

Figure V. (Cont'd) RECREATIONAL RESOURCES

in Minnesota and in the Red River Basin. The lakes are a part of Red Lake Indian Reservation, and only the area on the northern and eastern shores of Upper Red Lake and the eastern shore of Lower Red Lake are available for recreational purposes.

Lower Red Lake is utilized for commercial fishing by residents of the reservation; however, Upper Red Lake is the center of walleye sport fishing in Minnesota. Other common species include perch, lake whitefish, northern pike, sheepshead, and goldeye. Reports indicate an increased use of public lands east of the lakes for hunting and snowmobiling.

Approximately 46 private recreational sites, comprising 1,955 acres, are associated (mainly) with smaller lakes in the subbasin such as Blackduck, Maple, Julia, Pine and Clearwater. Also, many summer homes have been constructed near these lakes. The Red Lake River is used for fishing and is designated a state canoeing and boating river.

The major cities and towns have a variety of county and municipal parks and school athletic fields totalling about 1,100 acres. These provide residents with a variety of non-water based recreational activities.

Other than the Agassiz National Wildlife Refuge, Federal waterfowl production areas, state wildlife management areas, and state and county forests, there are approximately 4,719 acres of recreational lands in the subbasin. The majority of these sites are under 15 acres in size; however, areas over 15 acres comprise 90 percent (4,241 acres) of the total acreage.

There are several proposed recreational sites in the subbasin, including the Pembina Trail, which is of historical interest, two access points for canoe routes, and 1,600 acres of natural prairie chicken habitat. In addition, the Northwest Regional Development Commission has proposed that the last remaining Tamarac Swamp in Pennington County (10 acres) should be acquired and developed for picnicking and nature interpretation.

Significant Environmental Elements

Social

Crookston, Thief River Falls, Bagley, and Red Lake Falls are the population centers of the subbasin. Recurrent flooding in Crookston constitutes the most acute flooding problem in the subbasin. Flooding of agricultural areas is limited to scattered small farms in the Red

River Valley. Crookston has adopted a floodplain management ordinance as a method of limiting flood damages to the city, particularly in the low-lying residential areas. The effects of flooding include damages to structures, roads, bridges, culverts, water supplies, and sewer systems. Flooding of agricultural lands results in damages to the land, drainage systems, farm buildings and equipment, and sanitary facilities. Other effects include damages to crops, delays in planting, and increased costs due to the removal of debris and increased weed control.

It should be noted that residents of the Red Lake Indian Reservation have reported a reduction in fishing and trapping productivity as a result of the construction of Red Lake Dam in 1956. The tribe depends heavily on fishing and trapping as sources of income. The economy of the tribe has been adversely affected by decreased levels of productivity.

Cultural

Twelve archeological sites have been identified to date, with over half representing components of Woodland cultures. The region was explored early by Euro-American fur traders and others who sought to discover the source of the Mississippi River. Sixteen historical sites have been recorded, but none are listed on the National Register of Historic Places. One is currently under nomination. Concerted documentary and field research could identify many more archeological and historical resources of local, regional, state, or national significance.

Soils

The subbasin is divided into three distinct physiographic areas: the Lake Plain, the Lake Washed Till Plain, and the Moraine. The soils are varied, having developed under different types of vegetation, topography, and drainage. Soils in the Lake Plain on the western edge of the subbasin are dense, uniform, impermeable lake clay with thicknesses ranging from a few feet to more than 120 feet. The nearly level land surface and the heavy texture of the soil causes poor natural drainage, which necessitates extensive ditching to remove excess strom runoff. The Lake Plain also has scattered areas of silt and sand and gravel beach deposits. The clay and silt areas are extensively cultivated, but cultivation in the beach deposit areas is not common because of the poor water-holding capacity of the soil.

The Lake Washed Till Plain contains sand, lake washed till, and large areas of peat. Agriculture is common in the lake washed till, but natural drainage is not adequate. Sandy areas are subject to poor drainage and serious wind erosion. The peat, which is generally only a few feet thick, results from wetness caused by a water table at, or very near, the land surface. Agriculture is limited in these areas because of poor drainage.

The Moraine is composed mostly of glacial till with portions of sand and gravel. The glacial till is sandy, clay-silt loam containing fine to medium gravel with scattered boulders. Slopes of the glacial till are usually well drained, but there are numerous closed depressions often containing a marsh or lake. Drought can be a problem on the hillsides of the better drained sand and gravel outwash deposits.

Water

Approximately nine percent of the total land area of the subbasin is occupied by water. In addition to several rivers, the subbasin contains many lakes, the largest being Upper Red Lake and Lower Red Lake. These are the largest waterbodies in the Red River Basin and are important for wildlife, water supply, and recreation.

Woodlands

The woodlands and brushy areas of the subbasin are significant as habitats for wildlife. They include the floodplain forests along the Red Lake River and tributary streams in the western part of the subbasin where agricultural development and other land uses have eliminated most natural communites. In this area, they serve as travel and migration corridors for animals. Data supplied by the Minnesota Land Management Information Service (MLMIS) indicated that 1,163,800 acres, or 31.7 percent, of the total area in the subbasin is forested. Red Lake River is the most heavily wooded subbasin on the Minnesota side of the Red River of the North Basin. (The Roseau River Subbasin follows closely, with 30.2 percent of its total area in forest land.) Table 9 shows a comparison of the percentage of woodland vegetation in each county of the subbasin between 1969 and 1977. Each county showed an increase in woodlands during

Table 9

COMPARISONS OF COUNTY PERCENTAGES OF WOODLAND VEGETATION BETWEEN 1969 AND 1977

County	Percentage of County Containing Woodland Vegetation 1969	1977	Change in Percent Composition
Marshall	11.5	17.1	+5.6
Polk	5.1	6.7	+1.6
Beltrami	48.4	62.4	+14.0
Koochiching	85.5	92.7	+7.2
Pennington	6.4	9.9	+3.5
Red Lake	9.9	12.5	+2.6
Itasca	80.6	85.3	+4.7
Clearwater	60.2	61.9	+1.7

Source: Minnesota Land Management Information Service in U.S. Fish and Wildlife Service (1980).

the eight-year period. This increase can be attributed in part to plantings of shelterbelts and windbreaks by local landowners around homesteads and streams and to the reestablishment of vegetation in the lower reaches of stream floodplains on lands that were formerly cultivated (U.S. Fish and Wildlife Service, 1980).

There is a significant need to preserve the woodlands, since they constitute such a large portion of the subbasin, and also because they are the most important major habitat type for wildlife. It is also desirable to enhance forest lands in the western portion, where agricultural development has removed most woodlands not subject to periodic overflows from stream flooding.

Wetlands

The wetlands of the subbasin are deemed important because of their many beneficial uses and values such as nutrient entrapment, floodwater

retention, groundwater recharge, habitats for plants and animals, and waterfowl production areas (Cernohous, 1979; U.S. Fish and Wildlife Service, 1980; E.O. 11990, dated 24 May 1977). The wetlands of the subbasin are also of commercial significance for production of wild rice. Of the 22,000 acres of wild rice paddies reported in 1972 in Minnesota, approximately 8,000 acres were located within the subbasin (Lundberg and Trihey, 1972, after U.S. Army Corps of Engineers, 1975, and Sorenson, 1973).

Polk County was the only county included by the subbasin that was surveyed during both the 1964 and 1974 wetland inventories conducted by the U.S. Fish and Wildlife Service. Table 10 gives the wetland data for these two years for Types 1, 3-7, and stockponds, where applicable. The 1964 inventory data represents a 25 percent sampling, and all numbers have been multiplied by 4 to achieve 100 percent values with the exception of Type 1. Type 1 wetlands were not inventoried in the 1964 survey, but previous studies have indicated that they comprise about 10-15 percent of total wetland acres and 60 percent of total wetland numbers in the Prairie Pothole Region. This information was used to calculate Type 1 estimates. The 1964 inventory data (expanded to 100 percent) is considered a conservative estimate. The 1974 sampling represented a 100 percent inventory. In addition to the wetland types surveyed in the 1964 investigation, exclusive of Type 1 wetlands, Types 6 and 7 and stockponds are included (U.S. Fish and Wildlife Service, 1980).

Table 11 shows a comparison on the 1964 and 1974 wetland inventory data for Types 3, 4, and 5. These data are comparable, since methods used in the 1974 survey allowed direct comparison of the same sampling locations at the 25 percent level sampling. These data show that the number and acres of Type 3, 4, and 5 wetlands in Polk County were reduced by 297 and 1,458 acres, respectively, during the 10-year period from 1964 to 1974.

Types 1, 3-7, and stockponds are expected to occur in the other counties of the subbasin, as well as Type 8-bogs. Data from the MLMIS show that 428,160 acres of marsh are located within the subbasin, which represents about 11.6 percent of the total area. As expressed earlier in the Problems and Needs section, there is a need to protect, conserve, and enhance the wetlands of the subbasin because of their many values and uses.

Table 10

1964 AND 1974 WETLAND INVENTORY DATA FOR POLK COUNTY, RED LAKE RIVER SUBBASIN

Wetland Types[a]	1964 Number	1964 Acres	1974 Number	1974 Acres
1[b]	1,721	2,718	--	--
3	2,097	5,340	1,432	8,413
4	537	5,251	438	4,138
5	234	7,526	351	15,745
6	--	--	416	4,277
7	--	--	4	40
Stock Ponds	--	--	146	--
TOTAL	4,589	20,835	2,787	32,613

[a]Type 1 - Seasonally flooded basins or flats
Type 3 - Shallow fresh marshes
Type 4 - Deep fresh marshes
Type 5 - Open fresh water
Type 6 - Shrub swamps
Type 7 - Wooded swamps

[b]Number of wetlands calculated at 60 percent of total wetland numbers; acres of wetlands calculated at 15 percent of total wetland acres.

Source: U.S. Fish and Wildlife Service, 1980.

Table 11

COMPARISON OF 1964 AND 1974 WETLAND INVENTORY DATA, SHOWING NUMBER, ACREAGE, AND PERCENT CHANGES FOR POLK COUNTY, RED LAKE RIVER SUBBASIN[a]

Wetland Type	Number	Percent	Acres	Percent
3	-259	-12.4	+113	+2.1
4	-18	-3.4	-1,392	-26.5
5	-20	-8.5	-179	-2.4
TOTAL	-297	-10.4	-1,458	-8.0

[a]Represents values multiplied to 100 percent from a 25 percent sample.

Source: U.S. Fish and Wildlife Service, 1980.

Waterfowl Production Areas

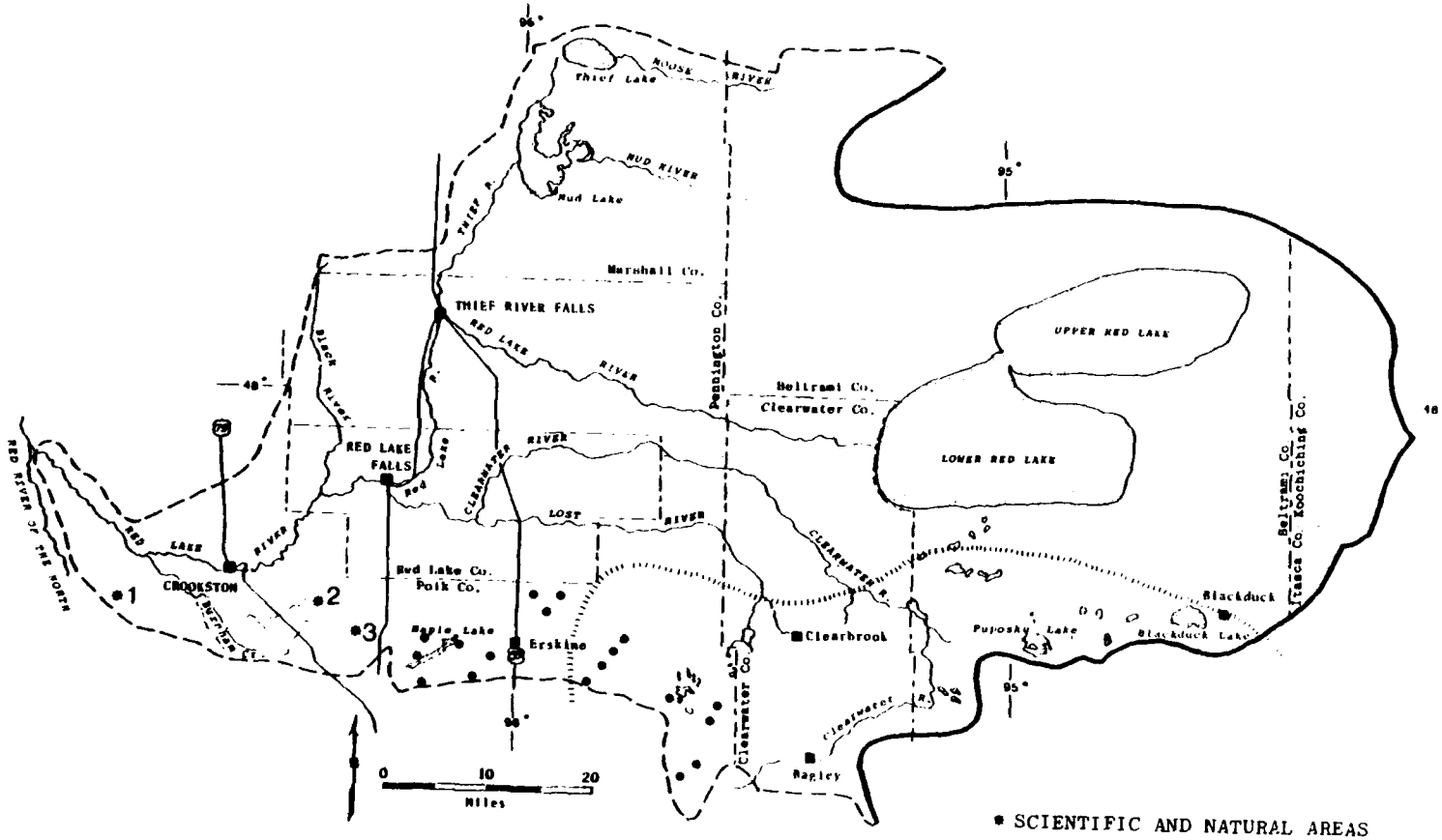
Eighteen Waterfowl Production Areas (WPAs) are located within tne subbasin. However, all of these are within Polk County. These WPAs are wetland areas that the U.S. Fish and Wildlife Service has acquired to preserve valuable breeding, nesting and feeding habitat for migratory waterfowl. These wetland areas are purchased with funds received from the sale of Migratory Bird Hunting and Conservation Stamps ("Duck Stamps"). These areas are significant because they provide the public with a great variety of wildlife-oriented recreational opportunities as well as provide valuable habitat for migratory waterfowl and many other forms of wildlife. The approximate locations of these WPAs (fee tracts) within the subbasin are shown in Figure VI.

Wildlife Management Areas

Wildlife management areas are considered important because of the opportunities provided for outdoor recreation and the protection and management given to biological resources within their boundaries. A listing of the areas and their respective acreages and location was presented in the Existing Conditions section for recreation.

Threatened and Endangered Species

Two species considered to be threatened or endangered occur within the subbasin: the eastern timber wolf, and bald eagle. The eastern timber wolf has declined in population because of pressures brought about by human civilization. All of the counties comprising the subbasin are included in the timber wolf's primary or peripheral range. The bald eagle population has declined in recent years because of loss of habitat and pesticide pollution, especially DDT and its derivatives. However, Minnesota has the second largest concentration of bald eagles in the United States. The most extensive population in Minnesota is located in the Chippewa National Forest, a portion of which is located within the subbasin in Beltrami and Itasca counties. Clearwater and Koochiching counties also have known breeding sites for the bald eagle.



- SCIENTIFIC AND NATURAL AREAS
  - 1 Miamberg Prarie
  - 2 Pankratz Memorial Prarie
  - 3 Pembina Trail Preserve
- WATERFOWL PRODUCTION AREAS (Fee Tracts)

Sources: The Nature Conservancy (no date); Miles and Yaeger (1979); U.S. Fish and Wildlife Service, 1980).

Figure VI. WATERFOWL PRODUCTION AREAS

Other Important Species

Ten species of mammals considered to be of priority status occur within the subbasin. Table 12 lists these species and their recorded locations, by county. One species, the plains pocket mouse, is known only from this region (Department of Natural Resources Region 1N) in northwestern Minnesota. A remnant herd of American elk is found in eastern Marshall and western Beltrami counties, primarily in the following areas: T. 157, R. 39; T. 158, R. 39; T. 158, R. 38; T. 157, R. 38. This herd is composed of 10-20 animals that will be maintained as free-roaming by the Minnesota Department of Natural Resources. A management plan is presently being developed (U.S. Fish and Wildlife Service, 1980).

The eastern greater sandhill crane is considered a threatened species by Minnesota that was reported from the region (Region 1N) only during the 1978 breeding bird survey. Also reported in the region during the survey were the marsh hawk and Franklin's Gull, both of which are considered to have a changing or uncertain status. A small population of great blue herons was reported in the region. This species is of special interest because of the scarcity of its nesting habitat such as coniferous swamps (Henderson, 1979; Moyle, 1974).

Three major rookeries or colonial bird nesting sites are located within the subbasin: (1) Agassiz National Wildlife Refuge in Marshall County; (2) Clearwater River in Clearwater County; and (3) Lake Julia in Beltrami County. Table 13 lists the colonial birds and the location of their rookeries within the subbasin.

There are no reptiles or amphibians officially considered to be endangered or threatened by the state of Minnesota or under the terms of the Federal Endangered Species Act of 1973. However, the Minnestoa Department of Natural Resources does recognize one reptile and three amphibians as species of special interest. The three amphibians (common newt, Canadian toad, and great plains toad) are species that occur at the extreme edges of their ranges in the subbasin. The smooth green snake is of special interest because it is restricted to a limited habitat of moist, grassy areas in plains or meadows (Henderson, 1979; Conant, 1975).

Table 12

DISTRIBUTION OF MAMMAL SPECIES OF PRIORITY STATUS OCCURRING WITHIN THE RED LAKE RIVER SUBBASIN

Species	Status*	County				
		Clearwater	Beltrami	Polk	Marshall	Pennington
Keen's Little Brown Bat	1	X				
Big Brown Bat	1	X				
Least Weasel	1	X			X	
Long-Tailed Weasel	1	X	X	X	X	
Spotted Skunk	1			X		
Cougar	1,2	X				
Southern Flying Squirrel	1,2	X				
Northern Flying Squirrel	1	X	X			X
Plains Pocket Mouse	3	X		X	X	
American Elk	4	X		X	X	

*1 - Reports needed to determine exact distribution and relative abundance.
2 - Hypothetical species that are presumed to occur in the area.
3 - Known only from this region.
4 - Extirpated from this portion of its former range.

Source: The Taxonomy, Distribution, Legal Status, and Utilization of Nongame Mammals in Minnesota. Minnesota Department of Natural Resources, 1979.

Table 13

COLONIAL BIRD NESTING SITES WITHIN THE RED LAKE RIVER SUBBASIN

	Location		
Species	Lake Julia	Clearwater River	Agassiz NWR
Great Blue Heron	X	X	X
Double Crested Cormorant		X	X
Franklin's Gull			X
Forster's Tern			X
Great Egret			X
Eared Grebe			X
Western Grebe			X
Black Crowned Night Heron			X

Source: An Inventory of Colonial Water Bird Nesting Sites in Minnesota. Minneapolis Department of Natural Resources, Fall, 1978.

The pug-nosed shiner has been reported from Beltrami and Itasca counties by the Minnesota Natural Heritage Program (1980). This agency has listed the pug-nosed shiner as a rare species in Minnesota.

The Assiniboia skipper butterfly is dependent upon prairies and is declining in numbers. The Assiniboia skipper is listed as rare (Minnesota Natural Heritage Program, 1980).

Several plants found in the counties included within the subbasin have been listed as rare by the Minnesota Natural Heritage Program (1980). One of these plants, Orobanche ludoviciana, is a parasite on the roots of members of the composite family that grows on sandy soils. The other species grows in four different habitats: (1) moist prairie meadows and woodlands; (2) emergent in ponds and lakes; (3) in or along bogs and swamps; and (4) dry hills and plains. Species growing in the damp

meadows include Carex capillaris var. major, Carex exilis, Eleocharis pauciflora var. fernaldi, Poa arida, marsh rush, beak rush, Scottish asphodel, starwort, Adder's tongue fern, and Matricary grape fern. Potamogeton lateralis, Vasey's pond weed, and white water lily are rare emergent plants growing in ponds and lakes within the subbasin. The shorelines of bogs and swamps provide habitats for rare species such as Drosera anglica, Drosera linearis, twig rush, cuckoo flower, Jack-in-the-pulpit, dwarf bladderwort, smallwood orchid, and northern bur-reed. The rare plants growing in the dry plains and hills area include Gentiana affinis, Gentiana amarella, Chamaerhodos nuttallii, Potentilla effusa, ragwort, cat's paws, and reed grass (Ryoberg, 1932; Lakela, 1965; MacMillan, 1898).

Natural Areas

Malberg Prairie, one of three natural areas in the subbasin, is located three miles northwest of Eldred in Polk County. This small tract (80 acres) is a rare virgin prairie that supports indigenous plant species such as bluestem, needle grass, prairie June grass, and prairie sunflower. "Mima mounds", which are the result of former pocket gopher activities, are also found in the Malberg Prairie.

The Pankratz Memorial Prairie (314 acres) is also located in Polk County about seven miles southeast of Crookston. This tract is also a virgin prairie with plant species such as blue grama, needle grass, pasque flower, and little white ladyslipper, which is considered by Moyle (1974) as a species of special interest. Also located on the prairie is a huge glacial boulder that was once used by the bison as a rubbing stone.

The third natural area is known as the Pembina Trail Preserve. This is a 1,440-acre tract of grassland that supports several important species such as the prairie white-fringed orchid, prairie chicken, ruffed grouse, sandhill crane, and marbled godwit. White-tailed deer are also present. Because the Pembina Trail Preserve is situated along a remnant beach ridge of the Glacial Lake, it has geological significance as well. The locations of all three natural and scientific areas are shown on Figure VI.

V. FUTURE CONDITIONS

V. FUTURE CONDITIONS

The following is a description of the subbasin's future economic, social and environmental conditions and resources. This description is presented in terms of "most probable" and "without project" conditions.

Most Probable Economic Conditions

The Minnesota State Planning Agency expects only one of the six component counties (Red Lake) of this subbasin to lose population during the remainder of this century. Slow-to-moderate growth is forecast for the remaining counties, with rapid change taking place in Pennington, Beltrami, and Clearwater counties. Regional efforts are being directed toward establishment of agricultural processing industries, business district renovations, and public works construction and improvement in all counties. Thief River Falls and Crookston are the two communities expected to be the center of this growth. The former was selected by the Northwest Regional Development Commission as the region's primary growth center, noting its excellent location, steady growth, and diverse economy. Crookston's proximity to the Grand Forks area has precluded a role as the region's primary center; thus, it is a secondary center.

According to the Principles and Standards, specifications of future conditions should reflect OBERS Series E and E' projections as a basis, unless conditions unique to the study area dictate that OBERS may not be totally satisfactory. Projections of general economic and demographic indicators for the non-SMSA portions of the Grand Forks area appear to be underestimated, since they project steady decreases throughout the study period. Therefore, state, regional, and Gulf South Research Institute (GSRI) developed figures have been adopted as most probable. OBERS E and E' projections have, however, been designated as most probable for per capita income and future agricultural activities.

Data presented in Table 14 depicts population, employment, and per capita income (expressed in 1979 dollars) figures. These figures reflect the slow reversal during the past decade of historic population and employment decline trends. This reversal has resulted largely from the stabilization

Table 14

RED LAKE RIVER SUBBASIN, POPULATION, EMPLOYMENT, AND PER CAPITA INCOME PROJECTIONS, 1980-2030

Parameter	1970	1977	1980	1990	2000	2010	2020	2030
Population	52,157	57,672	60,000	66,000	72,600	80,000	88,000	97,000
Employment	18,777	23,069	24,000	26,400	29,000	32,000	35,200	38,800
Per Capita Income (Dollars)	$4,760	$7,709	$10,000	$13,000	$16,900	$22,000	$28,600	$37,100

Sources: U.S. Water Resources Council, 1972 OBERS Projections, Series E; Minnesota State Planning Agency; and Gulf South Research Institute.

of agricultural employment. Per capita income is forecast to rise at the rate set for the non-SMSA portion of the Bureau of Economic Analysis (BEA) area; i.e., some three percent per annum.

The recurrent flooding of urban development in Crookston will continue to be the most critical problem in the subbasin. Since the cultivated areas in the narrow Red Lake River floodplain are relatively scattered and limited in size, agricultural flooding is expected to remain fairly minor.

Most Probable Agricultural Conditions

Approximately 1.4 million acres within the subbasin are currently under cultivation, and wheat, barley, oats, and hay are the principal crops. The estimated value of the total production of these principal crops for 1980, using October 1979 Current Normalized Prices for Minnesota, is $70 million. Projections of total production through 2030 for the principal crops is presented in Table 15. The projected total production for 2030 represents a value of $114 million, using October 1979 Current Normalized Prices for Minnesota.

Table 15

RED LAKE RIVER SUBBASIN, PRINCIPAL CROPS
AND PROJECTED PRODUCTION, 1980-2030
(Production in Thousands)

Year	Wheat (Bushels)	Barley (Bushels)	Hay (Tons)	Oats (Bushels)
1980	10,640	8,033	332	6,030
1990	12,342	9,318	385	6,994
2000	14,045	10,604	438	7,959
2010	15,109	11,407	471	8,562
2020	16,173	12,210	504	9,165
2030	17,875	13,495	557	10,130

Sources: OBERS Series E'; and Gulf South Research Institute.

Evaluation of Flood Damages--Future Conditions

A summary of present and future average annual flood damages is presented in Table 16. Assuming a discount rate of 7 1/8 percent, average annual damages throughout the projection period are expected to be $2.3 million. Urban damages account for 86 percent of the equivalent average annual damages, and rural damages account for the remaining 14 percent.

Flood damages to residences, businesses, industrial structures, churches, schools, automobiles, house trailers, public property and contents are included in the urban damages category. Damages to streets and utilities (including water, gas, electricity, sanitary sewers, storm sewers, and telephone systems) are also taken into consideration. This category also includes loss of wages, loss of profits, expenditures for temporary housing, cleanup costs, and extra expenses for additional fire and police protection and flood relief.

Agricultural flood damages consist of crop and pasture damage, which may include costs of replanting, refertilizing, additional spraying, reduced crop yields, loss of animal pasture days, and other related flood losses.

Other agricultural damages consist of land damage from scour and gully erosion and deposition of flood debris; livestock and poultry losses; damages to machinery and equipment, fences, and farm buildings and contents (excluding residences); and damages to irrigation and drainage facilities.

Transportation damages include all damages to railroads, highways, roads, airports, bridges, culverts, and waterways not included in urban damages. In addition, all added operational costs for railroads and airlines and vehicle detours are included.

Future growth of urban flood damages was estimated to be an uncompounded (straight-line) rate of one percent per year for a 50-year period beginning in the base year, with no growth thereafter.

Agricultural crop flood damages were projected to increase at the same rate as crop income projections published in the 1972 OBERS Series E projection report. These crop income projections were prepared by the U.S. Economic Research Service (ERS) for the Red River of tne North region. Other agricultural flood damages were projected to increase at one-half of this rate.

Table 16

RED LAKE RIVER SUBBASIN, SUMMARY OF PRESENT AND FUTURE AVERAGE ANNUAL DAMAGES
URBAN, AGRICULTURAL, AND TRANSPORTATION
(October, 1979 Prices, 7 1/8 Percent Interest)

	Flood Damages									
Category	1980	1990	2000	2010	2020	2030	Increase 1980-2030	Average Annual Equivalent Factor	Average Annual Equivalent of Increase	Equivalent Average Annual Damages
Urban										
Crookston	1,753,600	1,929,000	2,104,300	2,279,700	2,455,000	2,630,400	876,800	.2903	254,500	2,008,100
Agricultural										
Crop	197,200	228,800	260,300	280,000	299,700	331,300	134,100	.2903	39,000	236,100
Other Agricultural	65,700	71,000	76,200	79,500	82,800	88,000	22,300	.2903	6,500	72,200
Transportation	9,100	9,100	9,100	9,100	9,100	9,100	--	--	--	9,100
TOTAL	2,025,600	2,237,900	2,449,900	2,648,300	2,846,600	3,058,800	1,033,200	.2903	300,000	2,325,500

Source: Gulf South Research Institute.

Transportation damages are not expected to change throughout the project life because of the long-term economic life associated with such structures as bridges, railways, roads, and culverts. In addition, it has been found that repairs to these types of structures rarely exceed the cost of a new structure, even with frequent flooding.

Most Probable Environmental Conditions

Implementation of point and nonpoint source pollution abatement measures will improve the quality of surface waters within the subbasin. Nonpoint source controls are expected to take a considerably longer period of time for implementation.

Barring changes in land use trends noted from 1969 to 1977, woodland habitats within the subbasin are expected to increase to the benefit of most wildlife species possibly occurring in the region. Conversely, wetlands will decrease in total number and areal extent, with subsequent reductions in plant and animal populations dependent upon these fragile ecosystems. Improvements in water quality will provide even better habitats for aquatic biota and wildlife. Periodic low flows will continue, but portions of the Red Lake River and its tributaries presently afford, and should continue to provide, quality aquatic environs for biota in spite of this condition.

Without Project Conditions

It is anticipated that the conditions that will prevail over the 50-year planning period in the absence of a plan to alter resource management procedures will be the same as those set forth previously under the most probable future scenario.

VI. EXISTING FLOODPLAIN MANAGEMENT PROGRAMS

VI. EXISTING FLOODPLAIN MANAGEMENT PROGRAMS

Institutions

The development of effective water resources management practices in the subbasin is affected by the large number of Federal, state, and local agencies involved in project planning and implementation. There are 44 Federal agencies with various types of jurisdiction, and 14 directly involved in the water and related land resource planning process. At the state level, 27 agencies are involved. There are also regional commissions, county agencies, and municipal entities. Differences in perspective and problems of coordination hamper the effective and speedy resolution of problems.

The subbasin is aided in water resources development by the inclusion of the area in the Red Lake River Watershed District, which formulated an Overall Plan in 1972 and has initiated flood control measures. There are also 10 soil and water conservation districts with jurisdiction in the subbasin; including those representing Red Lake, Pennington, East Polk, Marshall, Clearwater, Mahnomen, Beltrami, Lake of the Woods, Itasca, and Koochiching counties.

The Corps of Engineers completed channel improvement projects for flood control purposes in Red Lake River in 1956 and Lost River in 1966. The Soil Conservation Service (SCS) has not completed any projects within the subbasin; however, the Burnham Creek project is authorized for planning, and a project for Badger Creek has been approved by the Soil and Water Conservation Board.

The Corps of Engineers, the Red Lake River Watershed District, the Soil Conservation Service, the soil and water conservation districts, and the towns of Crookston, Thief River Falls, and Red Lake Falls are the main entities that should be taken into consideration in flood control planning for the subbasin. The Red Lake Reservation Tribal Council must also be consulted for flood control measures on Indian lands. The Headwaters and Northwest Regional Development Commissions have developed overall economic development plans that include the subbasin area.

Structural Measures

Improvements (Figure VII) completed by the Corps of Engineers on the Red Lake River and tributaries include the following:

1. Red Lake River--Straightening and enlarging of about 28 miles of the river's channel upstream from a point just below High Landing, along with the construction of an adequate control dam at the outlet of Lower Red Lake, the source of the Red Lake River, were completed in 1954.
2. Clearwater River--Straightening, deepening, and enlarging, 47 miles of the stream channel above mile 31.8 were completed in 1954.
3. Lost River--Snagging and clearing operations from its junction with Clearwater River to mile 20 and straightening, deepening, and enlarging the channel 23 miles upstream from mile 20 were completed on Lost River in 1966.

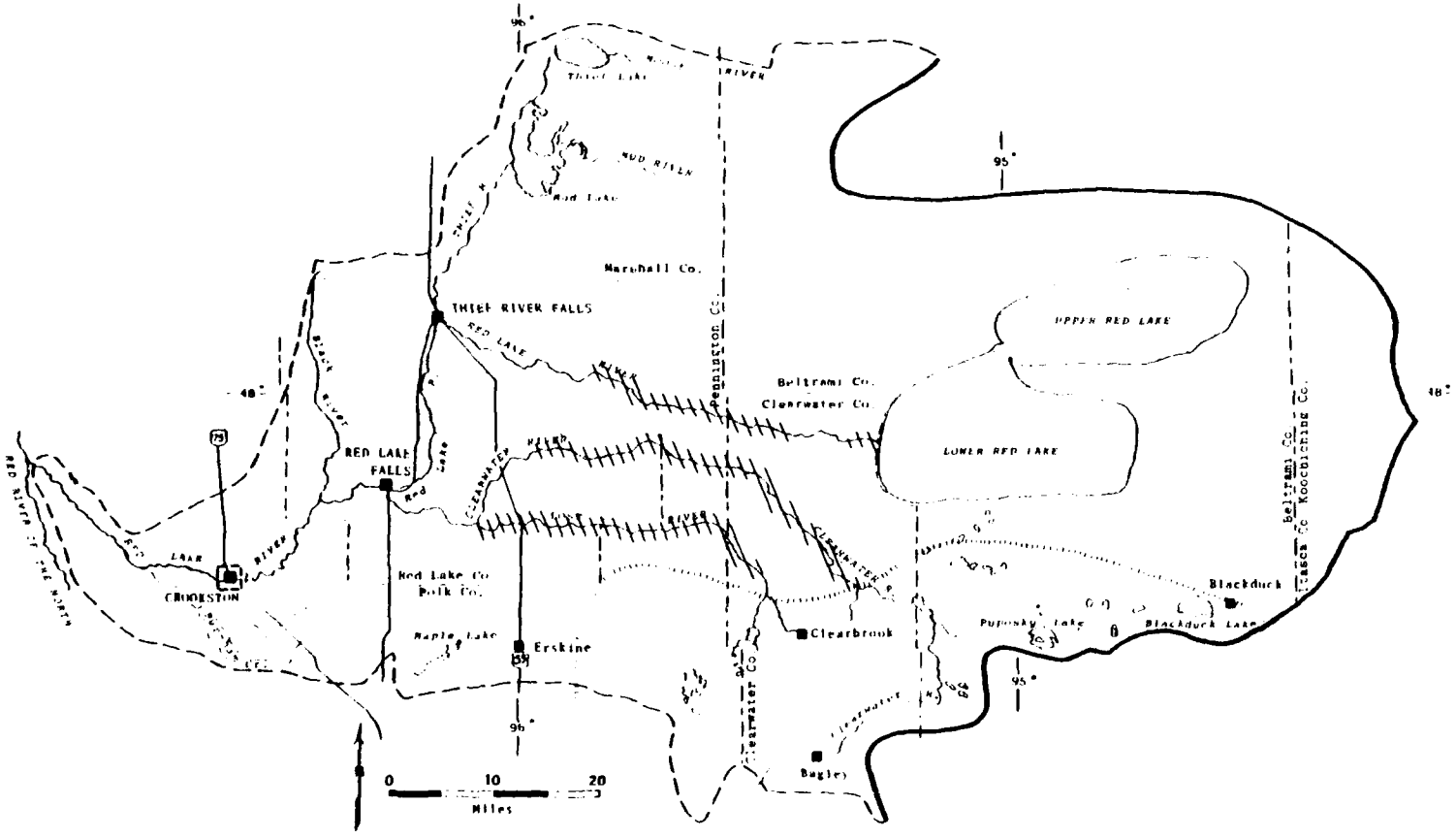
A study on Ruffy Brook (a tributary of the Clearwater River) by the Corps of Engineers in 1960 concluded that it was feasible to improve 3.7 miles of the channel to contain a 20 percent (five-year) frequency flood. These improvements were authorized, but the project is presently inactive because assurances of local cooperation were not provided.

About 3.1 miles of emergency levees are situated at strategic points along the river banks in Crookston. Originally constructed in the 1950's, the levee system was raised, strengthened, and extended after the 1966 flood to provide additional protection for all flood-vulnerable areas except the South Crookston addition, which was later redeveloped in a manner consistent with the flood hazard. The levees, together with sandbagging and other emergency measures, have afforded protection to a stage of 27 feet (859.72).

There are no other existing, authorized, or planned flood damage reduction measures in the subbasin.

Nonstructural Measures

Nonstructural flood control measures are measures that reduce or eliminate flood damages through procedures that involve little, if any, construction efforts. The major types are flood warning, floodplain zoning, flood insurance, flood proofing, and floodplain evacuation. These measures are primarily applicable to urban areas.



Source: Gulf South Research Institute.

Figure VII. EXISTING FLOOD CONTROL MEASURES

The towns in the subbasin participate in the Red River Valley flood warning system. The flood warning system for the Red River Valley is a cooperative network organized by the National Weather Service in Fargo, North Dakota. Fifty volunteers throughout the basin report to the National Weather Service on a weekly basis during winter and fall and on a daily basis during spring and summer. The reportage covers all precipitation of 0.1 inch or more, including amounts of snow and water equivalent. This information is transmitted to the River Forecast Center in Minneapolis, where it is run through a computer system to determine probable flood stages. The predictions are then transmitted to the National Weather Service in Fargo, which releases them to the public through the news media. Communities are then able to engage in emergency actions to protect themselves from flood damages. Contacts with local officials indicate that the flood warning system generally works quite well in the subbasin.

Crookston, the major urban area in the subbasin, participates in the Federal flood insurance program and has a floodplain zoning ordinance and building codes. Two other urban areas, Red Lake Falls and Plummer, both participate in the Federal flood insurance program. In addition, the counties of Beltrami, Clearwater, Marshall, Pennington, Polk, and Red Lake all participate in the Federal flood insurance program. Clearwater County also has a county-wide floodplain zoning ordinance.

There are other types of measures that could be implemented in the subbasin to reduce flood damages but that are not directly applicable to urban areas. These measures would include such things as land treatment programs, use of present drainage ditches for floodwater storage, and use of natural areas for reversion to water retention use. Land treatment is used by some farmers in the subbasin, but the Soil Conservation Service has not been called upon to undertake a large-scale program. Present drainage ditches are not used for floodwater storage, and no plans have been developed for future use.

Information on natural storage areas and potentialities for increased storage is very limited. Indications are, however, that wetlands play a substantial role in controlling runoff, especially in combination with good land practices. Values on storage have averaged about 12 inches

per surface-acre of wetlands and have ranged to four times that amount (Cernohous, 1979). The amount of wetland habitat within the watershed area (or subbasin) is important: statistical studies indicate that in certain situations if a watershed has 15 percent of its area in wetlands or lakes, peak floods will be 60-65 percent lower than they would be in the absence of the wetland/lake area; if wetlands or lakes occupy 30 percent of the waterhsed, there will be a further reduction in flood peaks up to about 75 or 80 percent (Scientists' Report, National Symposium on Wetlands, 1978).

Adequacy of Existing Measures

Channel improvements on the Red Lake and Clearwater rivers were designed to contain the 10-year frequency flood. Flows for this flood were based on stream data compilations through the late 1940's. Updated flood frequency data indicate that the flows for the 10-year frequency flood have increased substantially; however, stream gage readings and channel profiles indicate that most of these improvements can still contain the updated 10-year frequency floods.

Even though the levee system at Crookston has prevented substantial and possibly catastrophic flood damages and losses, it cannot be considered safe, since it was constructed under emergency conditons. Both the levee system and the interior drainage facilities fail to meet Corps design standards. Thus, it would be unrealistic to assume that this system would provide assured protection against recurring flood stages such as those experienced in the past.

VII. CRITERIA AND PLANNING OBJECTIVES

VII. CRITERIA AND PLANNING OBJECTIVES

Floodplain Management Criteria

Technical, economic, and environmental criteria must be considered when formulating and evaluating alternative floodplain management measures for the subbasin.

The technical criteria used in formulating and evaluating alternatives for this report consisted of the application of appropriate engineering standards, regulations, and guidelines.

Economic criteria entailed the identification and comparison of benefits and costs of each measure. Tangible economic benefits or appropriate gains in environmental quality must exceed overall costs; however, in certain instances, considerations of appropriate gains in the other accounts (environmental quality, social well-being and regional development) could alter this requirement. All alternatives considered are scaled to a design which optimizes benefits. Annual costs and benefits are based on an interest rate of 7 1/8 percent and price levels and conditions existing in October 1979. A 50-year amortization schedule is used for the features considered.

Environmental considerations call for the formulation of measures that minimize objectionable or adverse environmental effects and maximize environmental benefits. Also, limited consideration was given to modifications based on coordination with state and Federal agencies, local interests, and citizen groups.

Planning Objectives

The primary planning objective of this study was to contribute to flood reduction needs in the subbasin and thereby provide protection from or reduction of flood losses. In conjunction with this economic objective, the study attempted to develop contributions to the environmental quality of the subbasin.

The development of planning objectives involved a broad-range analysis of the needs, opportunities, concerns, and constraints of the subbasin. On the basis of the identified problems, needs, and desires, the following planning objectives were established:

1. Contribute to protection from and prevention, reduction, or compensation of flood losses for the flood prone areas of the subbasin during the period of analysis.

2. Contribute, to the maximum extent possible, to the preservation of the quality of the existing riverine environment and enhance the environmental potential of the subbasin as a whole.

3. Contribute to the enhancement of recreational opportunities throughout the subbasin.

4. Contribute to the improvement of water quality in the lakes and in the rivers of the subbasin.

5. Contribute to the improvement of water supply in the western portion of the subbasin.

6. Contribute to the reduction of wind and water erosion throughout the subbasin.

7. Contribute to the developing trend toward increased irrigation throughout the subbasin.

8. Contribute to the reduction of wastewater management problems, particularly insofar as they relate to water quality.

9. Contribute to the development of small hydroelectric installations between Red Lake and Crookston.

VIII. FORMULATION OF ALTERNATIVE MEASURES

VIII. FORMULATION OF ALTERNATIVE MEASURES

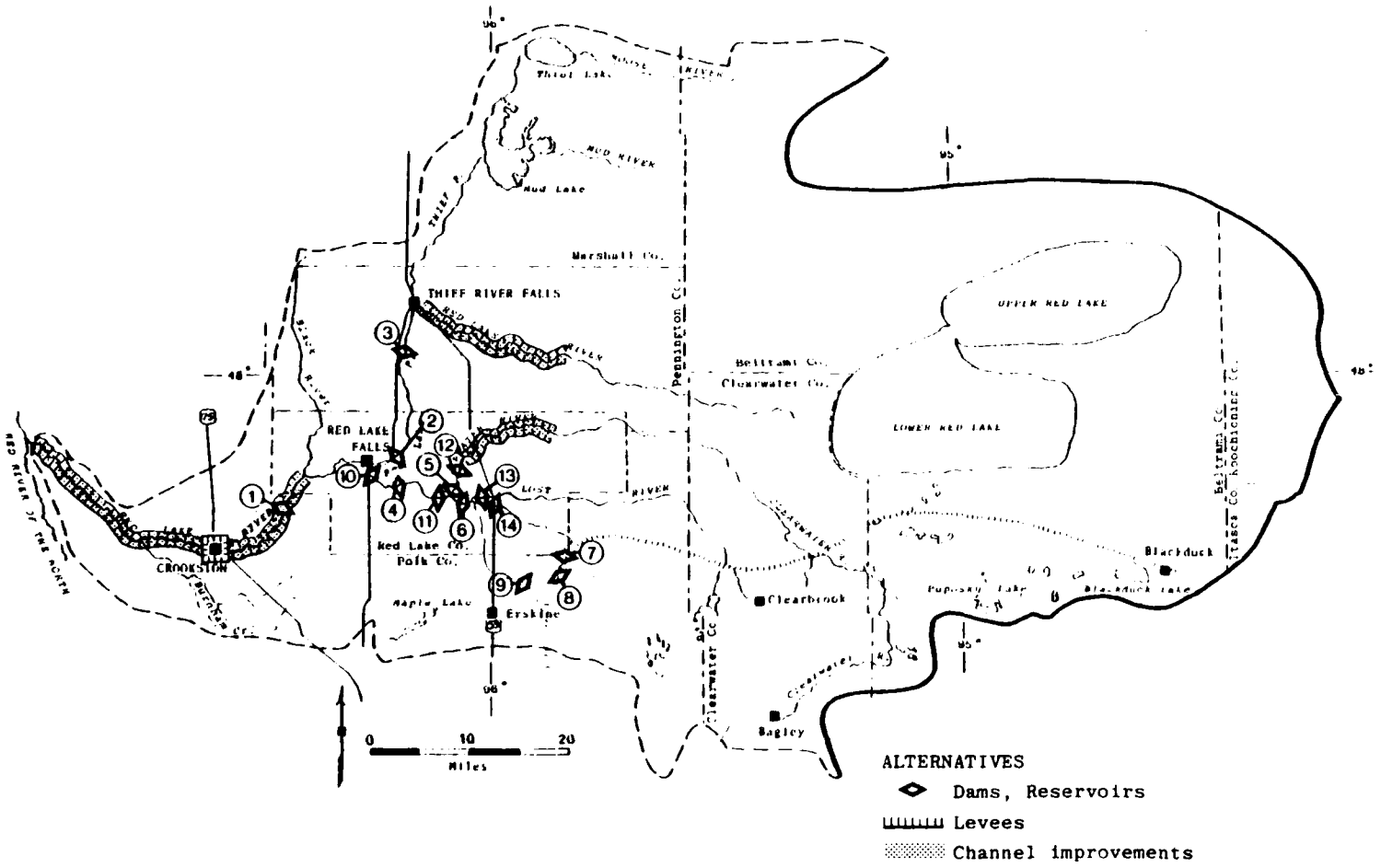
This section includes discussions of management measures identified from previous studies and investigations and other measures that have been formulated to meet the resource management objectives. The formulated measures give prime consideration to the resolution of flooding problems. Other planning objectives are considered exclusively as components to the flood control measures.

The following measures, shown in Figure VIII, were identified and devised in response to the flood control planning objective:

1. In 1977 the Corps of Engineers concluded a feasibility study for flood control and related purposes in the subbasin. A total of 13 alternatives, three non-structural and 10 structural, were formulated. Of these alternatives, one non-structural and five structural yielded benefit-cost ratios 0.5 or greater. These alternatives are more fully described as follows:

   a. Permanent levees and floodwalls at Crookston. Recurrent flooding at Crookston constitutes a major flood problem in the subbasin. A system of temporary earthen levees has been constructed. These levees, together with sandbagging and other emergency measures, have afforded protection to a stage of 27 feet. However, the levees cannot be considered safe, since they were constructed under emergency conditions and do not meet acceptable design standards. This alternative considers the raising and strengthening of 2.8 miles of the existing emergency levee system, construction of another 1.4 miles of floodwall where foundation conditions or other restrictions prevent levee raising, completion of almost one mile of channel enlargement, evacuation of about 12 residences, and construction of two channel cutoffs to protect flood prone areas of Crookston. Interior drainage facilities are included to prevent flooding behind the protective measures. Two vehicular bridges would have to be raised, and a railroad bridge would require modifications. Measures under this alternative would provide protection against a one percent (100-year) chance flood at Crookston.

   b. Huot dam and lake. This alternative consists of a large multiple-purpose reservoir for flood control, low-flow augmentation, recreation, and irrigation on the Red Lake River. The proposed damsite is at river mile 70.5, approximately three valley miles



Source: Gulf South Research Institute.

Figure VIII. ALTERNATIVE FLOOD CONTROL MEASURES

below Huot. This reservoir would have a storage capacity of about 240,000 acre-feet at the design pool. Of this capacity, 24,000 acre-feet would be reserved for sedimentation, 11,000 acre-feet for conservation storage, and 205,000 acre-feet exclusively for flood control. The dam would provide Crookston with adequate flood protection from a one percent (100-year) frequency flood and would partially alleviate flooding downstream along the Red River of the North. With this dam, peak flood stages at Grand Forks-East Grand Forks for floods from 1950 to 1979 could have been reduced on the order of one to two feet, and possibly even more, depending on the operation of the dam.

c. Reduced-sized reservoir at the Huot site (Site 1) in combination with reservoirs at eight other sites (sites 2, 3, 4, 5, 6, 7, 8, and 9). This alternative would consist of nine dams on the Red Lake River and its tributaries upstream of Crookston. Three dams (dams 1, 2, and 3) would be on the Red Lake River, two dams (dams 4 and 5) would be on the Clearwater River, two dams (dams 7 and 8) would be on Hill River, and one dam each would be located on Lost and Poplar rivers (dams 6 and 9, respectively). About 178,000 acre-feet of total reservoir storage would be available for a limited degree of downstream flood protection, low-flow augmentation, and water-based recreation. Individual reservoir storage capacities vary from 88,000 acre-feet to 2,500 acre-feet. This network of reservoirs would decrease the one percent (100-year) floodplain by approximately 71,000 acres.

d. Reduced-size reservoir at the Huot site (Site 1) in combination with reservoirs at 10 other sites (sites 2, 3, 7, 8, 9, 10, 11, 12, 13, and 14). This alternative consists of three dams (dams 1, 2, and 3) on Red Lake River, three dams (dams 10, 11, and 12) on Clearwater River, two dams (dams 7 and 8) on Lost River, a dam at the confluence of Hill and Lost rivers, and single dams on both the Lost River and the Poplar River (dams 13 and 9, respectively). About 172,000 acre-feet would be provided for flood protection, low-flow augmentation, and water based recreation. Storage capacities of the reservoirs vary from 88,000 acre-feet to 1,300 acre-feet. These reservoirs would reduce the one percent (100-year) floodplain by some 71,000 acres.

e. Reduced-size reservoir at Huot (Site 1) in combination with reservoirs at sites 2 and 4. This system of reservoirs would provide approximately 291,000 acre-feet of total storage capacity. This capacity would

be divided between reservoirs on Red Lake River near Huot, on Red Lake River upstream from Red Lake Falls, and on the Clearwater River downstream from the confluence of Lost River with Clearwater River. Protection against a one percent (100-year) frequency flood would be afforded for Crookston, and downstream rural areas would be afforded a somewhat lesser degree of flood protection.

f. Reduced-size reservoir at Huot (Site 1) in combination with increased-size reservoirs at sites 2 and 4. This alternative is the same as Alternative e, except for the capacities of the respective reservoirs. Under this alternative, about 299,000 acre-feet of total reservoir storage would be available. These reservoirs would also provide protection for Crookston from a one percent (100-year) frequency flood.

The implementing agency for the levee work at Crookston and the larger reservoirs would be the Corps, whereas the SCS or the Corps could be the implementing agency for the smaller reservoirs.

The present study attempted to identify potential reservoir sites other than those already identified by the Corps in its Red Lake Feasibility Study and described in the above alternatives. The Corps sites had been selected for their effectiveness in reducing flooding in problem areas of the subbasin, namely Crookston and the lower reaches of the Red Lake River. A cursory review of U.S.G.S. quadrangle maps of the subbasin revealed few, if any, remaining reservoir sites of any consequence. In most instances, additional sites interfere with the pool of sites already selected and do not provide a significant increase in storage capacity. For these reasons, no additional reservoir sites were considered in the present study.

In addition to the investigation of other potential reservoir sites, the present study undertook a determination of the reductions on Red River flows at Grand Forks that would occur if all Red Lake River Subbasin flows above Crookston could be controlled. The HEC-5 high-flow model for the Red River Basin was used for this determination. This analysis revealed that the reduction of flows at Grand Forks through total control of flows at Crookston is affected largely by the timing of the two streams at their Grand Forks confluence. It was also determined that peak Red River flows at Grand Forks would be reduced by an average of about 25 percent for spring floods. However, the timing of peaks on the two streams could vary as much as±10 percent. Therefore, the reduction in one percent flood crest elevations at Grand Forks through

the control of all Red Lake River flows at Crookston for 15 percent, 25 percent, and 35 percent Red River flow reductions would be approximately 1.2 feet, 2.2 feet, and 3.9 feet, respectively.

There would be reductions in summer events also. However, this would depend on how much rain fell and the location of the storm. A very heavy rain in the subbasin could be handled with a large flow reduction at Grand Forks. Control of flow at Crookston would have very little or no reduction on peak flows at Grand Forks resulting from large summer storms outside of the subbasin.

2. Improvement of 99 miles of the Red Lake River from East Grand Forks to river mile 78 and from about river mile 126 near Thief River Falls 21 miles upstream. These channel reaches would be modified to contain a 10 percent (10-year) frequency flood and would provide protection for Crookston and about 16,000 acres of farmland. In addition to channel modifications, levees would be required at Crookston to contain the flow. The implementing agency could be either the SCS or the Corps.

3. Improvement of 82.5 miles of the Red Lake River from East Grand Forks to river mile 48 and from river mile 56 to 90. The channel would be modified to contain a 30 percent (3.3-year) frequency flood and would provide protection for approximately 10,000 acres of farmland. The implementing agency could be either the SCS or the Corps.

4. Improvement of 13.3 miles of the Clearwater River from a point eight miles upstream from Plummer to river mile 53. The channel would be modified to contain a 10 percent (10-year) frequency flood and would provide protection for about 3,000 acres of farmland. The implementing agency could be either the SCS or the Corps.

5. Improvement of 11.3 miles of the Clearwater River from a point eight miles upstream from Plummer to river mile 51. The channel would be modified to contain a 30 percent (3.3-year) frequency flood and would provide protection for approximately 1,600 acres of farmland. The implementing agency could be either the SCS or the Corps.

6. Agricultural levees constructed along each side of: (a) the Red Lake River for about 53 miles in the lower reach; (b) the Red Lake River for about 34 miles in the reach just east of Thief River Falls; and (c) the Clearwater River for about nine miles. These levees would provide protection against a one percent (100-year) frequency flood for properties bordering the Red Lake and Clearwater rivers and would result in a water level rise of no more than 0.5 feet. The floodplain within the levees would vary from a 4,700-foot maximum to 200 feet at levee termination

points. The levees would provide full protection for Crookston and would protect about 47,000 acres in the 100-year floodplain. The implementing agency would be the Corps.

7. Construction of levees around farmsteads in floodprone areas. These levees would provide protection against a one percent (100-year) frequency flood and could be constructed by the SCS, the Corps, or private individuals.

In addition to the previous alternatives, several studies and reports relative to flood control measures have been accomplished for other areas in the subbasin. These studies and the status of each is as follows:

1. In June 1962, the Soil Conservation Service completed an interim survey report defining areas that would be affected by improvement of the Thief River channel, including estimates of benefits and costs associated with a local drainage improvement program. Based on the obtainable flood control benefits and an appropriately apportioned share of the related drainage benefits in the surrounding area, channel enlargement on the main stem did not appear to be economically feasible. The study was suspended in FY 1962 as a result of opposition to the considered improvements and a lack of local interest.

2. In March 1960, the Corps completed a general design memorandum for flood control measures on Lost River. This design memorandum resulted in the construction of the improvements to Lost River previously described under Existing Floodplain Management Programs. An excerpt from the design memorandum states:

> "In the preparation of the survey report only channel improvements as a means of flood alleviation was given detailed consideration since the extremely flat terrain of the region makes reservoir control and protection by means of levees impractical. A study of project formulation was made in the current investigation and it was found that for an incremental benefit-cost ratio of unity the project should be designed for a flood occurring once in 5.2 years (19-percent). It is therefore considered that the design flood as selected (once in five years) would be appropriate for the project."

As a result of this finding, improvements on Lost River for a high degree of flood protection were not considered in the present study.

3. In October 1967, the Corps completed a reconnaissance report for flood control measures on Thief River. An excerpt from this report states:

"Channel improvements on the Thief River for the 10-year design both alone and in combination with local drainage improvements has been found to be not economically feasible since the average annual costs exceed the average annual benefits. It is clear that a plan offering a degree of protection greater than the considered 10-year design would not be economically feasible since the average annual costs exceed the average annual damages. Conversely, the benefits from a plan offering a degree of protection less than the 10-year design would not be likely to exceed the cost."

In addition, "the Thief River channel improvement project would have adverse effects at Crookston and other downstream areas requiring remedial measures which would further reduce the benefit-cost ratio." In view of these factors, no further consideration for flood protection measures except for possible improvements against a 30 percent (3.3-year) frequency flood, were considered along the Thief River. The small land area flooded as a result of a 30 percent frequency flood does not warrant any type of improvements.

4. In April 1979, the Corps concluded a reconnaissance report for emergency snagging and clearing on the Poplar River. Snagging and clearing of 13.4 miles of the Poplar River was found to lack economic feasiblity.

5. In January 1979, the Soil Conservation Service completed a preliminary investigation report for the Burnham Creek Watershed, in which several tentative flood protection alternatives were formulated. Detailed planning is underway, and the draft watershed plan and environmental impact statement is scheduled for completion in mid-1980.

Engineering Methodology

All structural alternatives were analyzed on the basis of the effect of 1.0 percent (100-year), 10 percent (10-year), and 30 percent (3.3-year) frequency floods originating in the subbasin. Flood frequency data and peak flood elevations and flows were obtained from the Souris-Red-Rainy River Basins Study, Appendix D-Flood Damage Reduction, October 1970. These data were based on and compiled from four gaging stations located at the following points:

1. Red Lake River at Crookston
2. Thief River near Thief River Falls
3. Clearwater River at Plummer
4. Clearwater River at Red Lake Falls

From these data, elevation-discharge curves were developed, from which the 1.0, 10, and 30 percent frequency flood elevations at the respective gaging stations were determined.

Stream cross-sections were obtained from Corps design memorandums, floodplain reports, and channel water surface profile drawings and were estimated from U.S.G.S. Quadrangle Maps. Using the elevation-discharge and frequency discharge curves along with the stream cross-sections, the floodplains for the 1.0, 10 and 30 percent frequency floods were delineated throughout the subbasin along the major streams. From these data, flood damage reduction alternatives, the area flooded versus discharge curve, and area flooded versus chance of exceedence in one year curves for the alternatives were formulated. The latter curves were used to estimate average annual benefits that could be anticipated from each alternative.

In analyzing the channel alternatives, the Manning formula was used as the basis for determining channel capacity. Roughness coefficient values (Manning's "n") for channels and overbank conditions varied from 0.035 to 0.10. Channel grades were obtained from channel water surface profile drawings and prior reports and were extrapolated from U.S.G.S. Quadrangle Maps.

Capital costs were derived from either updating cost estimates from prior reports to October 1979 levels, or else by applying October 1979 unit construction costs. Construction cost indexes from Engineering News Record publications were used for updating prior cost estimates. The capital cost estimate for the agricultural levee alternative includes the cost of pumping facilities, which is based on portable pumping units with capacities for a 20 percent (five-year) frequency flood.

Nonstructural Measures

Among the nonstructural measures considered in previous reports were flood warning and forecasting services, emergency protection, permanent floodplain evacuation, and flood proofing. These measures are discussed in the following paragraphs.

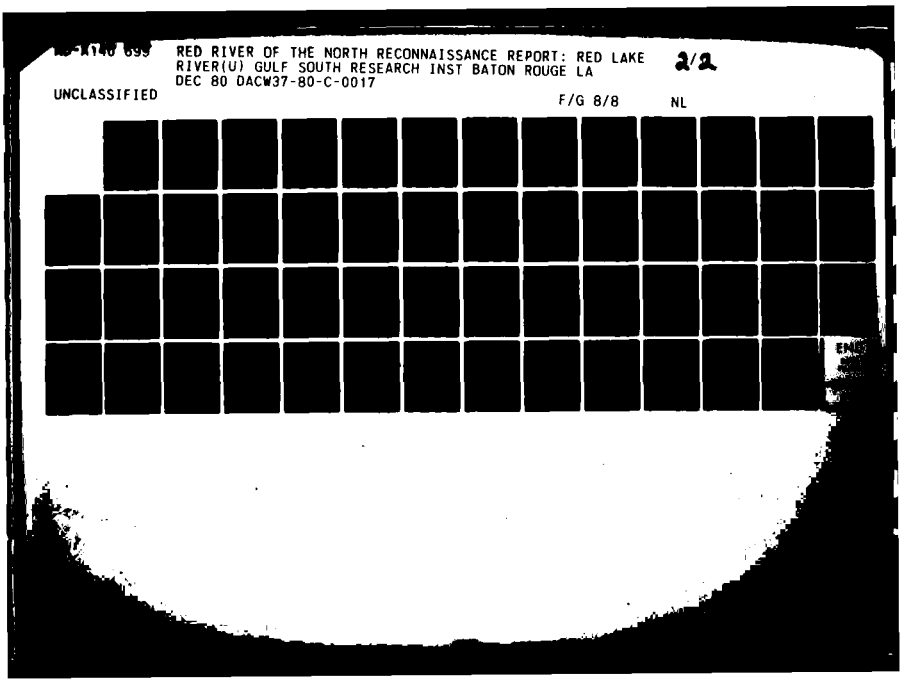
Floodplain regulation and flood insurance are currently required by the State of Minnesota and Federal policies and thus were identified as the base conditions. Floodplain regulations are intended to eradicate nonconforming uses of the floodplain, thereby reducing or eliminating flood damages in the long-run. However, because home and business owners in flood prone areas can obtain structural improvement loans through the purchase of flood insurance, and because the value of the contents of these structures is expected to increase, flood damages will increase in the short-run even with floodplain regulations in effect. With respect to rural areas, this alternative would do little to reduce flood damages. Crop damages could be reduced only to the extent that intensive farming practices would be discouraged in the long-run in the floodplain. However, because of the highly productive nature of floodplain farming, it is doubtful that any long-run shifts away from the intensive farming of floodplain areas would occur. Thus, the base condition is not seen to be an effective method for reducing flood losses in the subbasin.

Flood warning and forecasting services in conjunction with emergency protection have been used with reasonable success. However, the amount of time between the flood warning and forecasting and the actual flood event is critical to the type of emergency works that can be implemented. In addition, the larger the magnitude of the flood, the greater the structural stability problems caused by underlying soil conditions. In addition, a greater danger of failure would increase the potential for loss of life. Emergency protection measures would continue to inconvenience and disrupt residents of the floodplain and would disrupt the biological system and scenic quality of the area. Therefore, this alternative is not perceived as socially, environmentally, or economically acceptable as a solution to the total flood problem. However, it is recommended that flood warning and forecasting services be continued in order to alert floodplain residents of impending dangers.

Permanent evacuation of floodprone areas involves the purchase of lands, relocation of improvements, and resettlement of the population, ultimately resulting in the permanent conversion of land use to a state less susceptible to flood damages. Impacts of the implementation of

this alternative would primarily be cultural and economic in nature. Flood proofing would involve structural changes and adjustments to properties in an effort to reduce or eliminate flood damages. This is most effective when applied to new construction, but can be applied to existing structures in certain instances. Permanent evacuation would result in the disruption of long-established social and cultural relationships, but could eliminate flood damages to structural units providing floodplain regulations were enforced. Furthermore, the health and safety of floodplain residents would be benefited, and natural habitats would be improved. However, the residual damages to agriculture, and the economic, social, and cultural impacts would more than offset the benefits.

The preceeding discussion summarizes the results of Corps of Engineers investigations. In addition to the nonstructural measures mentioned in the Corps reports, there is an opportunity for the use of land treatment measures throughout the subbasin that would help to contain water on land as well as reduce erosion damages. Other measures would include but not be limited to water retention in existing ditches and preservation of natural retention areas. These would need to be identified, and retention capacities would need to be determined. Wetland restoration could also be considered, where appropriate, for water retention.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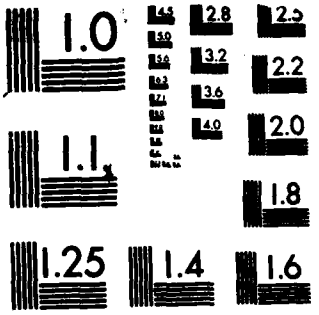

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IX. ASSESSMENT OF ALTERNATIVES

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Economic Assessment

Large lakes and extensive marsh areas in the subbasin tend to extend the duration of flood conditions. Recurrent flooding of urban areas, particularly in the vicinity of Crookston where several channel constrictions and low bridges exist, comprises the most critical problem in the subbasin. The Red Lake River Valley is narrow; thus, cultivated areas are scattered and limited in size, and agricultural flood losses are relatively minor. However, several tributaries experience localized flooding of rural areas that frequently results in serious economic losses to the farmers in these areas.

The economic effects of the flood control alternatives for the subbasin along with their costs and benefits are presented in Table 17. Since no information was available on weighted damages per a[illegible] for the subbasin, a figure was drawn from the Section 205, Detailed Project Report for Flood Control, Snake River Below Warren, Minnesota, which was published by the St. Paul District Corps of Engineers in 1979. Since the Snake River Subbasin is adjacent to the Red Lake River Subbasin, it was assumed that the weighted damage per acre figures of the Snake River would be representative of conditions along the Red Lake River.

Alternative one consists of permanent levees and floodwalls at Crookston, nearly one mile of channel enlargement, evacuation of about 12 residences, and two channel cutoffs to protect flood prone areas of Crookston. Interior drainage facilities are included to prevent flooding behind the protective measures. In addition, two vehicular bridges would have to be raised, and a railroad bridge would require modifications. The combination of measures under this alternative would provide protection against a one percent (100-year) frequency flood at Crookston. Economic evaluation of this alternative yielded a benefit/cost ratio of 0.83.

Alternative two (Huot dam and lake) consists of a large multiple-purpose reservoir for flood control, low-flow augmentation, recreation, and irrigation on the Red Lake River. This alternative would provide

Table 17

ECONOMIC EVALUATION OF ALTERNATIVES

Alternatives	Acres Protected	Average Annual Acres	Capital Costs	Average Annual Costs	Average Annual Rural Benefits	Average Annual Urban Benefits	Total Average Annual Benefits	B/C Ratio
1. Urban levees, and floodwalls at Crookston (1% flood)	--	--	$19,647,000	$1,446,200	--	$1,203,300	$1,203,300	0.83
2. Knot Dam and Lake Site 1 (1% flood)	--	--	42,480,000	3,127,000	--	--	1,642,900*	0.53
3. Reduced-Size Reservoir at Site 1 with Reservoirs at Sites 2,3,4,5,6,7,8 and 9 (1% flood)	70,000	--	47,436,000	3,491,800	--	--	1,158,700*	0.33
4. Reduced-Size Reservoir at Site 1 with Reservoirs at Sites 2,3,7,8,9,10,11, 12,13 and 14 (1% flood)	70,000	--	47,436,000	3,491,800	--	--	1,158,700*	0.33
5. Reduced-Size Reservoir at site 1 with Reservoirs at Sites 2 and 4 (1% flood)	--	--	56,817,000	4,182,300	--	--	1,642,900*	0.39
6. Reduced-Size Reservoir at Site 1 with Reservoirs at Sites 2 and 4 (1% flood)	--	--	59,649,000	4,390,800	--	--	1,642 900*	0.37
7. Red Lake River Channel Improvements (10% flood)	16,000	3,550	56,970,000	4,193,561	212,100	--	212,100	0.05
8. Red Lake River Channel Improvements (30% flood)	10,000	875	43,500,000	3,202,000	52,300	--	52,300	0.02
9. Clearwater River Channel Improvements (10% flood)	3,000	1,380	1,886,000	138,800	82,500	--	82,500	0.59
10. Clearwater River Channel Improvements (30% flood)	--	357	534,000	39,300	21,300	--	21,300	0.54
11. Agricultural Levees (1% flood)	47,000	2,750	84,827,000	6,244,100	164,300	1,753,600	1,917,900	0.31
12. Farmstead Levees (Per Levee)	--	--	5,600	400	840	--	840	2.10

*Information available did not reveal the proportions of the benefits that could be claimed as either rural or urban.

Source: Gulf South Research Institute.

one percent (100-year) frequency flood protection at Crookston and 10 percent (10-year) frequency flood protection for rural areas downstream. Economic evaluation of this alternative yielded a benefit/cost ratio of 0.53.

Alternative three consists of a reduced-size reservoir at the Huot site (Site 1) in combination with reservoirs at eight other sites (sites 2, 3, 4, 5, 6, 7, 8, and 9). This network of reservoirs (three on the Red Lake River, two on the Clearwater River, two on the Hill River, and one each on the Lost and Popular rivers) would decrease the one percent (100-year) frequency floodplain by approximately 70,000 acres. Economic evaluation of this alternative yielded a benefit/cost ratio of 0.33

Alternative four consists of a reduced-size reservoir at the Huot site (Site 1) in combination with reservoirs at ten other sites (sites 2, 3, 7, 8, 9, 10, 11, 12, 13, and 14). This network of reservoirs consists of three dams on Red Lake River, three dams on Clearwater River two dams on Lost River, a dam at the confluence of Hill and Lost rivers and Popular River. This alternative would reduce the one percent (100-year) frequency floodplain by approximately 70,000 acres. Economic evaluation of this alternative yielded a benefit/cost ratio of 0.33.

Alternative five consists of a reduced-size reservoir at Huot (Site 1) in combination with reservoirs at sites 2 and 4. This network of reservoirs consists of a reservoir upstream of Red Lake Falls on the Red Lake River, the reduced-size Huot dam, and a dam on Clearwater River downstream from the confluence of Lost and Clearwater rivers. Protection against the one percent (100-year) frequency flood would be afforded for Crookston. Downstream rural areas would be afforded a somewhat lesser degree of flood protection. Economic evaluation of this alternative yielded a benefit/cost ratio of 0.39.

Alternative six consists of a reduced-size reservoir at Huot (Site 1) in combination with increased size reservoirs at sites 2 and 4. This alternative is the same as alternative five, except for the capacities of the respective reservoirs. Economic evaluation of this alternative yielded a benefit/cost ratio of 0.37.

Alternative seven consists of 99 miles of channel improvement of the Red Lake River from East Grand Forks to river mile 78 and from river mile 126 near Thief River Falls to 21 miles upstream. These channel reaches would be modified to contain a 10 percent (10-year) frequency flood and would provide protection for Crookston and about 16,000 acres of farmland. In addition to the channel modifications, levees would be required at Crookston to contain the flow. Economic evaluation of this alternative yielded a benefit/cost ratio of 0.05.

Alternative eight consists of improvement of 82.5 miles of the Red Lake River from East Grand Forks to river mile 48 and from river mile 56 to river mile 90. The channel would be modified to contain a 30 percent (3.3-year) frequency flood and would provide protection for approximately 10,000 acres of farmland. Economic evaluation of this alternative yielded a benefit/cost ratio of 0.02.

Alternative nine consists of 13.3 miles of channel improvements to the Clearwater River from a point eight miles upstream from Plummer to river mile 53. The channel would be modified to contain the 10 percent (10-year) frequency flood and would protect about 3,000 acres of farmland. Economic evaluation of this alternative yielded a benefit/cost ratio of 0.59.

Alternative 10 consists of 11.3 miles of channel improvements to the Clearwater River from a point eight miles upstream from Plummer to river mile 51. The channel would be modified to contain the 30 percent (3.3-year) frequency flood and would provide protection for approximately 1,600 acres of farmland. Economic evaluation of this alternative yielded a benefit/cost ratio of 0.54.

Alternative 11 consists of agricultural levees constructed along each side of: (1) the Red Lake River for about 53 miles in the lower reach; (2) the Red Lake River for about 34 miles in the reach just east of Thief River Falls; and (3) the Clearwater River for about 9 miles. These levees would provide a one percent (100-year) frequency flood for properties bordering the Red Lake and Clearwater rivers and would result in a water level rise of no more than 0.5 feet. The levees would provide full protection for Crookston and would protect about 47,000 acres of the 100-year floodplain. Economic evaluation of this alternative yielded a benefit/cost ratio of 0.31.

Alternative 12 consists of the construction of levees around individual farmsteads in floodprone areas. The levees would provide protection against a one percent (100-year) frequency flood. Economic evaluation of this alternative yielded a benefit/cost ratio of 2.10.

Impact Assessment

Twelve structural measures were investigated for their anticipated effects on key resource elements in the event of implementation. The following discussion elaborates on the rationale pursued in the assignment of ratings presented in Table 18.

Urban Levees and Flood Walls-Crookston

Prevention of flood damages at Crookston would result in moderately beneficial social and economic effects to the community and subbasin. These beneficial effects include the reduction or prevention of damages to and/or loss of personal property, the potential for disruptions in the delivery of emergency services, drains on community services, temporary or permanent loss of community facilities, loss of community tax base, and losses in personal income. In addition, such measures would serve to reduce many of the negative behavioral consequences associated with flooding problems. No known effects would be experienced by land use, water quality and supply, known cultural elements, and recreational elements.

Minimally adverse environmental and biological impacts would accrue as a result of project construction. Some streamside floodplain vegetation would be destroyed by project construction, and there would be minor degradation in aesthetic qualities and temporary air and noise pollution.

Huot Dam and Lake

The proposed dam and lake would have maximally beneficial economic and social effects because of the reduction of flood damages in the subbasin, including one percent chance flood protection for Crookston and 10 percent chance protection for downstream rural areas. Similar beneficial effects would be experienced along the Red River of the North, particularly in the Grand Forks-East Grand Forks area.

Table 18

ASSESSMENT OF MEASURES, BY RESOURCE ELEMENT, RED LAKE RIVER SUBBASIN

Measures	Social	Economics	Land Use	Biology	Water Quality	Water Supply	Cultural	Recreation
1. Urban Levees and Floodwalls-Crookston	MoB	MoB	NE	MiA	NE	NE	NE	NE
2. Huot Dam and Lake	MaB	MaB	MoA	MaA	MaA	NE	MoA	MoB
3. Reduced-size reservoir and eight smaller reservoirs (1% flood)	MoB	MoB	MiA	MoA	MoA	NE	NE	MoA
4. Reduced-size reservoir and ten smaller reservoirs (1% flood)	MoB	MoB	MiA	MoA	MoA	NE	NE	MoA
5. Reduced-size reservoir and two smaller reservoirs (1% flood)	MoB	MoB	MaA	MaA	MaA	NE	NE	MoA
6. Reduced-size reservoir and two smaller reservoirs (1% flood)	MoB	MoB	MaA	MaA	MaA	NE	NE	MoA
7. Channel Improvements-Red Lake River (10% flood)	MoB	MoB	NE	MaA	MaA	NE	NE	MiA
8. Channel Improvements-Red Lake River (30% flood)	MiB	MiB	NE	MoA	MaA	NE	NE	MiA
9. Channel Improvements-Clearwater River (10% flood)	MiB	MiB	NE	MaA	MoA	NE	NE	MiA
10. Channel Improvements-Clearwater River (30% flood)	MiB	MiB	NE	MaA	MoA	NE	NE	MiA
11. Agricultural Levees	MoB	MoB	NE	MoB	MiA	NE	NE	MiB
12. Farmstead Levees	MiB	MiB	NE	NE	NE	NE	NE	NE

Note: NE = No Known Effect
MiA = Minimally Adverse
MoA = Moderately Adverse
MaA = Maximally Adverse
MiB = Minimally Beneficial
MoB = Moderately Beneficial
MaB = Maximally Beneficial

Source: Gulf South Research Institute.

It is estimated that 30 farms or homesteads would require relocation, as would several highways. Some 7,600 acres (of which approximately 4,000 acres are in cropland and pasture) would require purchase of or flowage easements for reservoir development. Persons living in protected areas would experience less urban and rural community disruption and fewer threats to public health and safety during flood periods. Overall, social benefits were deemed to be maximally beneficial.

Making farming in the floodplain more profitable could well influence land use and agriculture. Total project land would encompass about 7,600 acres, of which 4,000 are in agricultural use and 3,600 are in woodland (1,000 acres), lots, or parkland. In addition, more intensive use of existing lands and possible clearings for additional farming might well occur. The net effects from a land use standpoint would be moderately adverse.

Maximally adverse biological impacts would result from the proposed measure. The project would modify or destroy existing ecosystems of floodplain forests, agricultural lands, and streambeds. Reduction and changes in habitat and disruption of ecological balances would affect vegetation and wildlife well beyond the limits of the design flood pool. Water quality would also be maximally adversely affected. Thirty-seven point source discharges are located on Red Lake River (mostly upstream from the dam site). This would tend to enhance the eutrophication process in the lake. Turbidity and sedimentation would be affected by construction. The lake would, however, trap sediments that would otherwise travel to downstream reaches.

Although recreational enjoyment of river canoeing, fishing, and hunting would be adversely affected, recreational effects were judged maximally beneficial because the 240,000 acre-feet pool would provide boating, lake fishing, and other general reservoir amenities. Water supply would not be affected by Huot. Moderately adverse effects on cultural elements would result from losses associated with a historical site, state park, religious monument, and cemetery.

Series of Small Reservoirs and Reduced-Size Reservoir at Huot

Four series of combinations of a reduced-size reservoir at the Huot location plus dams at various locations on the Red Lake, Clearwater, Hill, Lost, and Popular rivers are being considered for further investigation. Individual storage capacity would vary from 1,300 to 88,000 acre-feet, and the various combinations would reduce the one percent floodplain by some 70,000 acres. These measures would have moderately beneficial social and economic effects.

Detrimental biological, land use, and environmental effects similar to the ones described above for the Huot Dam and Lake can be anticipated. The extent of such losses and changes, however, vary from measure to measure, with the greatest losses anticipated with respect to the systems requiring the greatest storage capacity and largest number of impoundments on various streams.

Despite the fact that these reservoirs would provide lake-associated recreation, the detrimental effects on existing fishing, hunting, and canoeing in the various rivers warrant a moderately adverse rating for recreational elements. No known effects on water supply would be associated with these measures, and there are no known effects on cultural elements.

Channel Improvements

Channel improvement measures were considered for the Red Lake and Clearwater rivers. By and large, these improvements would yield minimally beneficial social and economic effects and the entire range of adverse biological and water quality effects. Minimally adverse recreational effects would take place, since valuable canoeing and fishing activities would be affected by the measures. No known effects would take place with respect to cultural elements, water supply, and land use.

Social and economic benefits would accrue through various levels of flood protection afforded by the specific measures. Over 1,600 acres would be protected if 11 miles of the Clearwater River were improved, and Crookston and 16,000 acres of farmland would be protected if 99 miles of the Red Lake River were improved. Two channel improvement measures would contain the 10 percent flood, and the remaining two would contain the 30 percent flood.

Maximum to moderate adverse effects would take place with respect to most fish and wildlife and water quality resources, mostly because of changes in the character of the existing waterbodies and their habitat features.

Agricultural Levees

Agricultural levees constructed along each side (in selected reaches) of the Red Lake and Clearwater rivers would provide protection against a 100-year frequency flood to properties in Crookston and about 47,000 largely agricultural acres. Vegetation communities would be protected and habitats would be expanded or created in association with the levee setbacks. Temporary turbidity would minimally adversely affect water quality. Small recreation benefits would result from the utilization of borrow pits for fishing purposes. Water supply, land use, and known cultural elements would probably not be affected.

Farmstead Levees

Localized minimally beneficial economic and social effects would result from the protection of farmsteads from frequent floods by development of ring levees. Other resource elements would not be notably affected, although aesthetic, sanitary, and maintenance factors would need to be considered.

X. EVALUATION

X. EVALUATION

Only the farmstead levees have benefits that exceed unity. These measures are also the only ones that maximize economic benefits for the subbasin, but they afford only extremely localized protection. High average annual urban benefits are associated with the reservoirs proposed for the Red Lake and Clearwater rivers. However, the average annual costs are much larger than the average annual benefits. The urban levees and floodwall measures considered for Crookston had a benefit to cost ratio of 0.83, the highest following the farmstead levees.

The greatest environmental enhancement would result from the agricultural levees on the Red Lake and Clearwater rivers, where the large setbacks would provide protection to the riparian belt and would create or expand habitats.

National Economic Development (NED) and Environmental Quality (EQ) plans will be tentatively formulated in association with the Red River of the North basin reconnaissance report.

XI. ADDITIONAL STUDY NEEDS

XI. ADDITIONAL STUDY NEEDS

This report was developed almost entirely on the basis of secondary information from readily available planning documents. Data available from state and Federal agencies was not fully canvassed, and only a limited number of calls were made to the area. In particular, state university libraries and department resources could not be fully utilized. Thus, the document aims only at a broad-brush perspective. In order to provide a more detailed and in-depth analysis of subbasin resources, problems, and potential solutions, the following additional study needs would have to be fulfilled:

1. A literature search should be conducted to obtain recent biological data for the subbasin. In those areas where flood control measures have been proposed, field work should be planned to fill in any existing data gaps and to update information relevant for impact evaluation.
2. Areas of high environmental quality (e.g., prairie remnants) should be identified and inventoried within the subbasin.
3. Knowledge of the location, areal extent, and types of wetlands occurring within the specific subbasin boundaries (specifically in those counties other than Polk County) would be extremely useful in ascertaining whether wetland restoration would assist in alleviating flooding problems, as has been indicated by Cernohous (1979).
4. Sediment quality and updated water quality data are needed to characterize baseline conditions in the streams of the subbasin, especially in those areas where structural flood control measures have been proposed.
5. Information pertaining to wastewater management needs to be updated.
6. The information obtained in items 1-5 above would provide an important data base upon which an impact evaluation of proposed flood control measures can be performed and would provide information relative to the cumulative effects of flood control projects on environmental resources in the subbasin. These projects include those that are in-place or proposed.
7. Nonstructural flood damage reduction measures should be thoroughly explored such as those listed below.

- Establishment of buffer areas and curtailment of inappropriate residential, commercial, and other development in floodplains.
- Maintenance and enhancement of existing riparian vegetation along the Red Lake River and tributaries to conserve and restore wildlife habitats, help control wind and streambank erosion, retain soil on the land, and to reduce the amount of sediment, nutrients, and other pollutants entering waterways.
- Maintenance of grassed waterways to reduce erosion.
- Establishment of vegetation in areas of critical erosion.
- Determination of the feasibility of installing water control structures at existing culverts to retain water in drainage ditches for longer periods of time during critical runoff periods to minimize flooding in downstream areas.
- Determination of the feasibility of utilizing "on-farm storage" to control runoff through such means as natural storage areas and control structures on existing culverts.
- Prevention of overgrazing on grasslands and utilization of sound agricultural land use practices.
- Provision for strict enforcement of floodplain management programs within the subbasin.

8. The potentiality for land treatment measures (e.g. erosion control measures such as cover crops, green belts, reduction in fall tillage, etc.) needs to be thoroughly investigated.
9. The people of the subbasin need to be included in further water resource planning efforts. A public involvement program would provide more complete information on water resource problems and opportunities than is presently available.
10. Studies are needed to determine additional demand for recreational facilities, usage of existing facilities, and potential sites.
11. A review of secondary sources and systematic field reconnaissance is needed to identify archaeological and historical sites and to determine their eligibility for nomination to the National Register of Historic Places.
12. A detailed social profile of the subbasin is needed.
13. A detailed institutional analysis of the subbasin is needed.
14. Subbasin boundaries need to be better defined on the basis of hydrologic conditions, and total acreage in the subbasin needs to be precisely measured.

15. An adequate 100-year floodplain map needs to be developed. Also, the extent of floodplains for smaller frequency storms needs to be delineated.

16. Land use within the floodplain needs to be precisely identified.

17. The irrigation potentials of the subbasin soils need to be investigated.

18. The effect of drainage works on flood discharges and stages is unknown at present. It would take additional, more detailed studies to determine the extent and effect of reduced natural storage.

19. Potentialities for floodwater storage in present drainage ditches need to be investigated.

20. Crop distribution in the floodplain needs to be precisely identified through contact with county agents, and average annual rural damages need to be updated.

21. Urban damages need to be recomputed in a systematic fashion.

22. Whether forested acreages in the floodplain are increasing or declining needs to be precisely determined.

23. More study is needed to determine the precise nature of the water supply problems and potential solutions.

24. More gauging stations need to be developed to provide hydrologic data for establishing flood frequencies and rating curves.

25. Channel cross-sections of the various streams need to be prepared for flood control planning purposes.

26. Potentialities for temporary floodwater storage in wild rice paddies need to be investigated.

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Appendix A
FLOODPLAIN DELINEATION

Appendix A

FLOODPLAIN DELINEATION

Prior to this study, no attempt was made to publish even a generalized delineation of the entire Red Lake River floodplain. In undertaking this task, the present study utilized all known sources to provide the best available data for generalized delineation at a scale of 1:250,000. Principal sources were: USGS Flood Prone Area Maps (scale 1:24,000), Federal Insurance Administration flood maps (various scales), published secondary sources, U. S. Geological Survey (USGS) 7 1/2 minute topographic maps, and other sources, including derived data where necessary.

The Flood Prone Area Maps published by the USGS provided detailed and highly accurate information for the area mapped. Eight sheets covering the western part of the subbasin represent the available coverage. Since this particular area contains the major urban areas within the subbasin, the delineated 100-year flood zone proved extremely helpful.

Federal Insurance Administration Flood Hazard Boundary Maps and Flood Insurance Rate Maps provide important coverage of the Minnesota portion of the Red River Basin. The former are designed only to delineate the 100-year floodplain. The latter are much more detailed and usually more accurate. A Rate Map for Itasca County indicated no floodplain in the small portion of the county within the subbasin. Boundary maps for Polk, Red Lake, Beltrami, Clearwater, and Koochiching counties formed the basis for the delineation in Figure II. No coverage was available for Pennington, Marshall, and Mahnomen, since these counties entered the emergency flood program in 1974 and have not as yet been mapped.

Secondary sources, such as the Souris-Red-Rainy River Basins Type II Study (delineating the Red River main stem floodplain) were also utilized. Published floodplain descriptions and acreage estimates in the 1972 Red Lake Watershed District Overall Plan, the 1979 Burnham Creek Watershed preliminary investigation report, and other sources contained helpful information regarding the location and extent of the floodplain. USGS 7 1/2 minute topographic maps of relevant areas were also available for consideration.

Appendix B

INVENTORY OF OUTDOOR DECREATIONAL FACILITIES (WILDLIFE MANAGEMENT AREAS) RED LAKE RIVER SUBBASIN

Appendix B

INVENTORY OF OUTDOOR RECREATIONAL FACILITIES (WILDLIFE MANAGEMENT AREAS)
RED LAKE RIVER SUBBASIN

Number	Name	Location	Boundary Acres	WMA Managed Acres	Date[1]
1	Thief Lake WMA	Marshall Co. 15841W36 Moose River	34,874.0	33,772.0	72
2	Whiteford WMA	Marshall Co. 15741W07 Mud Lake Reservoir	80.0	80.0	71
3	Mudlac WMA	Marshall Co. 15742W23 Mud Lake Reservoir	240.0	240.0	71
4	East Valley WMA	Marshall Co. 15642W20 Mud Lake Reservoir	120.0		76
5	Grygla WMA	Marhsall Co. 15739W36 Grygla	420.0	320.0	71
6	Northwood WMA	Beltrami Co. 15738W23 Moose River	160.0	160.0	71
7	Eckvoll WMA	Marshall Co. 15640W29 Mud Lake Reservoir	6,440.0	6,440.0	71
8	Elm WMA	Marshall Co. 15542W24 Red Lake Reservoir	16,280.0	14,853.0	71
9	Agder WMA	Marshall Co. 15542W27 Red Lake Reservoir	240.0	240.0	71
10	Espelie WMA	Marshall Co. 15539W09 Grygla	160.0	160.0	71
11	SEM WMA	Marshall Co. 15539W33 Grygla	2,677.8		71

Appendix B (Cont'd)

INVENTORY OF OUTDOOR RECREATIONAL FACILITIES (WILDLIFE MANAGEMENT AREAS)
RED LAKE RIVER SUBBASIN

Number	Name	Location	Boundary Acres	WMA Managed Acres	Date[1]
12	Carmelee WMA	Beltrami Co. 15538W34 Lee Township	160.0	160.0	72
13	RC-2 WMA	Beltrami Co. 15537W31 Hamre Township	160.0	160.0	72
14	RC-1 WMA	Beltrami Co. 15536W03 Steenerson Township	160.0	160.0	72
15	Red Lake WMA	Beltrami Co. 15532W15 Upper Red Lake	184,437.6	184,437.0	72
16	Sanders WMA	Pennington Co. 15344W07 Thief River Falls	80.0		78
17	Higinbotham WMA	Pennington Co. 15244W09 St. Hilaire	880.0	400.0	72
18	Pembina WMA	Red Lake Co. 15245W29 Little Black River	132.0		71
19	Moran WMA	Red Lake Co. 15145W21 Hnot	107.0	107.0	71
20	Red Lake Falls WMA	Red Lake Co. 15144W13 Red Lake Falls	200.0		76
21	Gervais WMA	Red Lake Co. 15143W25 Terrebonne	101.5	80.0	71
22	Emardville WMA	Red Lake Co. 15242W36 Clearwater River	200.0		77
23	Oklee WMA	Red Lake Co. 15141W16 Oklee	280.0		76
24	Stipa WMA	Polk Co. 15045W11 Crookston	160.0		78

Appendix B (Cont'd)

INVENTORY OF OUTDOOR RECREATIONAL FACILITIES (WILDLIFE MANAGEMENT AREAS)
RED LAKE RIVER SUBBASIN

Number	Name	Location	Boundary Acres	WMA Managed Acres	Date[1]
25	Marcoux WMA	Red Lake Co. 15044W24 Marcoux	364.3	318.0	71
26	Brooks WMA	Red Lake Co. 15042W36 Brooks	520.2		77
27	Lessor WMA	Polk Co. 14941W02 Lessor Township	680.0	320.0	71
28	Gully WMA	Polk Co. 15139W15 Clearwater River	480.0	440.0	71
29	LeBlanc WMA	Clearwater Co. 15038W06 Berner	162.6	162.0	71
30	Hangaard WMA	Polk Co. 15039W34 Gully	25.0	25.0	71
31	Kertsonville WMA	Polk Co. 14945W16 Crookston	360.0		71
32	Tympanuchus WMA	Polk Co. 14945W28 Crookston	480.0	480.0	72
33	Foxboro WMA	Polk Co. 14845W03 Crookston	320.0		76
34	Dugdale WMA	Polk Co. 14844W05 Fertile	817.0	792.0	72
35	Trail WMA	Polk Co. 14845W13 Fertile	480.0		76
36	Shypoke WMA	Polk Co. 14844W07 Fertile	338.4	80.0	71
37	Tilden WMA	Polk Co. 14944W25 Tilden Township	600.0	368.0	72

Appendix B (Cont'd)

INVENTORY OF OUTDOOR RECREATIONAL FACILITIES (WILDLIFE MANAGEMENT AREAS)
RED LAKE RIVER SUBBASIN

Number	Name	Location	Boundary Acres	WMA Managed Acres	Date[1]
38	Erskine WMA	Polk Co. 14942W36 Badger Lake	869.9	869.0	72
39	Bee WMA	Polk Co. 14842W07 Bee Lake	365.0	88.0	71
40	Maple Meadows WMA	Polk Co. 14844W23 Fertile	2,100.0	820.0	71
41	Dorr WMA	Polk Co. 14842W18 Dorr Lake	287.0	215.0	71
42	Kaakaik WMA	Polk Co. 14942W26 Badger Lake	200.7	151.0	71
43	Polk WMA	Polk Co. 14942W36 Badger Lake	1,027.0	389.0	78
44	Enerson WMA	Polk Co. 14940W19 Emerson Lake	450.0	254.0	71
45	Hill River WMA	Polk Co. 14940W35 Hill River	264.7	45.0	71
46	Brandsvolo WMA	Polk Co. 14840W10 Breed Lake	184.0	145.0	71
47	Mac Meadow WMA	Polk Co. 14841W20 McIntosh	1,245.0		71
48	Mulejohn WMA	Polk Co. 14839W14 Sand Lake	240.0		71
49	Sagaiian WMA	Polk Co. 14739W17 Popler Lake	281.8	165.0	71
50	Lengby WMA	Polk Co. 14739W29 Lengby	304.0	120.0	71

Appendix B (Cont'd)

INVENTORY OF OUTDOOR RECREATIONAL FACILITIES (WILDLIFE MANAGEMENT AREAS)
RED LAKE RIVER SUBBASIN

Number	Name	Location	Boundary Acres	WMA Managed Acres	Date[1]
51	Little Pine WMA	Clearwater Co. 14838W04 Little Pine Lake	380.0	316.0	71
52	Shotley WMA	Beltrami Co. 15332W23 Upper Red Lake	29.7	29.7	71
53	Shooks WMA	Beltrami Co. 15130W11 Kelliher	19.3	19.0	71
54	Clearwater-10 WMA	Clearwater Co. 14936W02 Bagley Lake	23.9	23.9	71
55	Clearwater-9 WMA	Clearwater Co. 14936W02 Bagley Lake	42.4	42.0	71
56	Clearwater-11 WMA	Clearwater Co. 14636W09 Spike Lake	40.0	40.0	71
57	Clearwater-8 WMA	Clearwater Co. 14836W17 West Four Legged Lake	20.9	21.0	71
58	Old Red Lake Trail WMA	Clearwater Co. 14837W24 Salberg Lake	1,150.0	1,150.0	71
		Total Acres:	263,733.0	249,706.9	

[1]Date of latest information.

Source: Minnesota Department of Natural Resources, Division of Parks and Recreation.

Appendix C
COMMENTS

Appendix C
COMMENTS

The purpose of this subbasin report was to provide an overview of the water and related resource problems and needs and to assess potential solutions. Toward this end, draft copies of this report were circulated to Federal, State, and local agencies and comments were sought.

This review resulted in complete and factual documentation. Thus, the study should serve as a building block for the timely completion of future water resource efforts within the subbasin. Further cooperative efforts are, however, needed to evaluate these tentative results and to develop potential solutions.

A distribution list and copies of the comments made with respect to the draft report are included as part of this appendix. Comments that resulted in specific modifications to the draft text are marked by an asterisk.

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
1135 U S POST OFFICE & CUSTOM HOUSE
ST PAUL, MINNESOTA 55101

REPLY TO
ATTENTION OF:

NCSED-PB

28 August 1980

Mr. Mike Liffmann
Project Manager
Gulf South Research Institute
8000 GSRI Avenue
Baton Rouge, Louisiana 70808

Dear Mr. Liffmann:

The draft Red Lake River subbasin report was distributed for review and comment. Most of the reviewers have sent their comments to us.

a. Inclosure 1 includes letters from various Federal and State agencies.

b. Inclosure 2 is the general office comments that need to be considered when preparing the final Red Lake River subbasin report and the remaining subbasin reports and the overall document.

c. Inclosure 3 identifies specific office concerns that are applicable to the Red Lake River subbasin report.

If you have any questions on our comments or proposed modifications, please contact us.

Sincerely,

Louis E Kowalski

LOUIS E. KOWALSKI
Chief, Planning Branch
Engineering Division

3 Incl
As stated

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

316 North Robert Street, St. Paul, MN 55101

June 24, 1980

Colonel William W. Badger
District Engineer
St. Paul District, Corps of Engineers
1135 U. S. Post Office and Custom House
St. Paul, Minnesota 55101

Attention: NDSED-PB

Dear Colonel Badger:

We have reviewed the draft Red Lake River Subbasin Report prepared by GSRI and offer the following comments for your consideration:

1. The map on pages 5, 9, and elsewhere in the report has a hatched line that runs from just east of Erskine through Blackduck in the southeast portion of the watershed. The legend should indicate what this represents.

* 2. Page 21, last paragraph. At the present time, studies are in progress for a flood control project in the Burnham Creek Watershed. This study is being carried out by SCS and local units of government under the authority of the Watershed Protection and Flood Prevention Act (PL-566).

3. Page 73 Items 2 through 6 list the SCS as a possible implementing agency for various channel improvements and diking measures. PL-566 limits work to watershed areas of less than 250,000 acres. Exceptions can be made by breaking into less than 250,000 acre units, planning these units concurrently with separate applications and plans for each, and installing needed improvements in the upper reaches first and proceeding by units downstream.

4. Comments made previously on other subbasin reports also apply to the Red Lake River Subbasin.

Thank you for the opportunity to review this document.

Sincerely,

Jon V. DeGroot
Asst. State Conservationist

United States Department of Agriculture
Soil Conservation Service
P. O. Box 1458
Bismarck, ND
58502

June 26, 1980

Colonel William W. Badger
District Engineer
St. Paul District, Corps of Engineers
1135 U.S. Post Office and Custom House
St. Paul, Minnesota 55101

Dear Colonel Badger:

We appreciate the opportunity to review the Red River of the North reconnaissance study draft report for the Red Lake River Subbasin. Following are comments concerning the report:

1. Page 11 - To the reader it would appear there is a mistake in the figure used for average annual urban flood damages. If the figure is correct they should include some notation as to why the average annual urban flood damage is greater than the two floods in reference (1975 and 1979).

2. Page 49 - In the previous page narrative it is discussed that Type 1 wetlands were not inventoried in 1964 yet Table 10 shows a figure for 1964 and none for 1974. The figures in Table 10 and 11 do not correspond for Type 3, 4, and 5 wetlands. As an example, on Table 10 Type 3 wetland numbers decrease between 1964 and 1974 by 665 with the acres increasing by 3,073. On Table 11 the numbers of Type 3 wetlands decrease by 259 with an acre increase of 113. It would appear if these figures are correct that more explanation is needed.

3. Pages 89-91 - The section on additional study needs appears to be a catalogue of wishes. Some of the study needs are repetitious, e.g., #16 and #22, #15 and 25 (#25 would be accomplished to complete #15). It might help the reader if they would prioritize the study needs in relation to the problems.

Sincerely,

Charles E. Mumma
Assistant State Conservationist (WR)

United States Department of the Interior
FISH AND WILDLIFE SERVICE
IN REPLY REFER TO
St. Paul Field Office, Ecological Services
538 Federal Building and U S Court House
316 North Robert Street
St. Paul, Minnesota 55101

July 31, 1980

Colonel William W. Badger
District Engineer, St. Paul District
U.S. Army Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

Dear Colonel Badger:

This provides U.S. Fish and Wildlife Service comments on the Draft Reconnaissance Report recently compiled by Gulf South Research Institute for the Red Lake River Subbasin in Marshall, Polk, Pennington, Red Lake, Clearwater, Koochiching, Itasca, Mahnomen, and Roseau Counties, Minnesota. As expressed in our comments on previous Subbasin Reports, our concerns are associated with the woodland, grassland, wetland, riverine, and riparian floodplain habitats that remain within the Red Lake River Subbasin. Most of the grassland, woodland, and wetland habitat in the western part of the Subbasin has been converted to agricultural uses. Some native grassland habitat (bluestem prairie) still exists along the Red Lake River and in those areas that have not been farmed. Remaining woodland habitat in the western part of the Subbasin is primarily confined to the floodplain of the Red Lake River, Clearwater River, Thief River, and other tributary streams or to scattered woodlots. Page 13 of the Report indicated that wetland drainage is a significant problem in the Subbasin. We agree with the statements on pages 13, 27, 31, 32, 46, 47 and 48 that these remaining grassland, woodland, and wetland habitat types are significant and need to be protected, conserved and enhanced within the Subbasin.

The Red Lake River is also of major concern because of its importance as a recreational, water power and scenic resource. The river supports very good populations of sport fish such as northern pike, walleye, channel catfish, rock bass, and bullheads. The river is an excellent walleye stream for much of its length from the Red Lakes to Crookston. The Red Lake River is also particularly noted for its channel catfish angling. Some of the most heavily fished areas are located below the Ottertail power dams in Crookston and Red Lake Falls, and near the three junctions of the Red Lake River with the Thief, Clearwater and Black Rivers. The stretch immediately below the Red Lakes is not easily

reached and has been heavily channelized, but between Thief River Falls and Red Lake Falls the stream is a splendid wild river with good fishing opportunities. The Red Lake River is also a state designated canoeing and boating route and has been described and mapped in the state's new canoeing guide, A Gathering of Waters. This varied route of 165 miles between the outlet dam on Lower Red Lake to the river's mouth at East Grand Forks includes wild bog country, the rapids and pools of the Campbell Beach stretch, and the plains of the Red River Valley. In addition, Red Lake River is also the source of municipal water supply for the three largest cities in the Subbasin - Crookston, Thief River Falls, and East Grand Forks. As such, no measures should be undertaken within the Subbasin that would inappropriately degrade this extremely important riverine resource.

Other important wildlife and recreational resource areas of concern that also should be preserved include the Upper and Lower Red Lakes, Clearwater and Thief Rivers, Agassiz National Wildlife Refuge and the various wildlife management areas, waterfowl production areas, and scientific and natural areas within the Subbasin.

The Report primarily addressed twelve structural alternative measures that have been considered to date to help reduce the flooding problems within the Subbasin. The Report indicated, however, that only one of these measures (farmstead levees) had a favorable B/C ratio and appeared to be economically feasible. We do not anticipate any significant adverse environmental impacts due to this alternative provided that the dikes are not constructed through wetland areas and impacts to existing woodland and grassland vegetation are avoided to the extent possible. Our comments relative to the other structural measures (reservoirs, urban and agricultural levees and channel improvements) addressed in the Report are similar to those provided on previous Subbasin Reports.

Some non-structural measures were briefly discussed on pages 65, 76, 77, 78, 89, 90 and 91 of the Report. We believe a plan involving a combination of structural and nonstructural measures (as identified on page 4 of our previous letter on the Draft Reconnaissance Report for the Tamarac River Subbasin) should be implemented. We also believe that additional studies (particularly numbers 3, 7, 8, 18, 19 and 22 identified on pages 89-91 of the Report) need to be undertaken to provide a more detailed and in-depth analysis of existing Subbasin problems and the potential solutions to many of these problems.

In addition, we suggest that the following changes be made in the Final Report:

*1. Page 13, 1st paragraph under the heading Environmental Concerns, 5th sentence - change this sentence to read as follows:

Although wetland inventory data is limited for the Subbasin, information exists which indicates that the number and acres of type 3, 4, and 5 wetlands in Polk County were reduced by 10.4 percent and 8.0 percent, respectively, during the ten year period from 1964 to 1974 (see Table 11). In addition, roughly 50,000 to 60,000 acres of wetland habitat within the Subbasin has also been adversely affected or destroyed as a result of early marsh drainage and the Red Lake and Clearwater River channelization projects.

*2. Page 41, 2nd paragraph under the heading Recreation Resources, last sentence - change this sentence to read as follows:

In addition, there are 18 waterfowl production areas open to the public for hunting and other wildlife-oriented forms of recreation.

*3. Page 44, 4th paragraph, 1st sentence - change this sentence to read as follows:

Other than the Agassiz National Wildlife Refuge, federal waterfowl production areas, state wildlife management areas and state and county forests, there are approximately 4,719 acres of recreational lands within the Subbasin.

*4. Page 48, 2nd paragraph, last sentence - change this sentence to read as follows:

These data show that the number and acres of type 3, 4, and 5 wetlands in Polk County were reduced by 297 and 1,458 acres, respectively, during the 10-year period from 1964 to 1974.

*5. Page 50, 1st paragraph under the heading Waterfowl Production Areas - change this paragraph to read as follows:

Eighteen Waterfowl Production Areas (WPA's) are located within the Red Lake River Subbasin. However, all of these are within Polk County. These WPA's are wetland areas that the U.S. Fish and Wildlife Service has acquired to preserve valuable breeding, nesting and feeding habitat for migratory waterfowl. These wetland areas are purchased with funds received from the sale of Migratory Bird Hunting and Conservation Stamps ("Duck Stamps"). These areas are significant because they

provide the public with a great variety of wildlife-oriented recreational opportunities as well as provide valuable habitat for migratory waterfowl and many other forms of wildlife. The approximate locations of these WPA's (fee tracts) within the Subbasin are shown in Figure VI.

*6. Page 51, Figure VI - put (Fee Tracts) in parenthesis after Waterfowl Production Areas in the legend.

7. Page 54, Table 13 - we suggest the locations of these colonial bird nesting sites be identified on a map (possibly on Figure VI) as was done for waterfowl production areas and scientific and natural areas.

*8. Page 65, 3rd paragraph, last sentence - we suggest this sentence be changed and the following statements be included in this paragraph:

Information on natural storage areas and potentialities for increased storage is very limited. Indications are, however, that wetlands play a substantial role in controlling runoff, especially in combination with good land treatment practices. Values on storage have averaged about 12 inches per surface-acre of wetlands and have ranged to four times that amount (Cernohous, 1979). The amount of wetland habitat within the watershed area (or Subbasin) is important: statistical studies indicate that in certain situations if a watershed has 15% of its area in wetlands or lakes, peak floods will be 60-65% lower than they would be in the absence of the wetland/lake area; if wetlands or lakes occupy 30% of the watershed, there will be a further reduction in flood peaks up to about 75 or 80% (Scientists' Report, National Symposium on Wetlands, 1978).

9. Page 79, 1st paragraph under the heading Economic Assessment - we agree that large lakes and extensive marsh areas (such as peat bogs) with drainage outlets tend to extend somewhat the duration of flood conditions. We suggest, however, that the value of these wetland areas in storing flood waters, and thus reducing the flood discharge rate, flood peaks and flood damages in the downstream areas of the Subbasin also be addressed in this paragraph.

*10. Page 80, Table 17 - the last three alternatives listed in this Table should be numbered 10, 11 and 12 (not 0, 1 and

2) as identified on pages 82 and 83 of the Report.

*11. Page 82, 4th paragraph, 1st sentence - change this sentence to read as follows:

Alternative 10 consists of 11.3 miles of channel improvements to the Clearwater River from a point eight miles upstream from Plummer to river mile 51.

*12. Page 84, Table 18 - number these alternatives 1-12 like in Table 17 on page 80. In addition, the Table should indicate that alternatives 9 and 10 (Channel Improvements on the Clearwater River) would create Moderately Adverse or Maximally Adverse effects on biology and water quality as described on page 87 as opposed to Minimally Adverse effects as indicated in Table 18.

*13. Page 91 - we suggest that the following additional study need also be included on this page:

Potentialities for temporary floodwater storage in wild rice paddies needs to be investigated (see page 25 of the Report).

14. Page 95, Bibliography - include the following reference on this page:

National Wetlands Technical Council. 1978. Scientists' Report. National Symposium on Wetlands. 129 pp.

These comments have been prepared under the authority of and in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et. seq.) and are consistent with the intent of the National Environmental Policy Act of 1969.

Sincerely,

Richard F. Berry

Richard F. Berry
Field Office Supervisor

cc: Minn DNR, St. Paul
S.Bittner, Gulf So. Res. Inst.

U.S. Army Corps of Engineers

North Central Division

Comments on the

Draft Red Lake River Subbasin

June 1980

Cmt. No.	Page & Para.	Comment
1.		Figure II is a poor map cartographically. There needs to be a legend which clearly describes the patterning used to delineate the 100-year floodplain, marshy areas, etc.
2.		Would suggest modifying the explanation of nonstructural measures. Would suggest incorporating the following thoughts. Nonstructural measures modify the susceptibility of land, people, and property to damage or losses. In addition, they modify the impact of flooding upon people and communities. Nonstructural measures do not attempt to modify the behavior of floodwaters.
3.		Add a discussion of the National Objectives (NED & EQ) as established by P & S.
4.		The list of objectives is basically good but awkwardly written. Would suggest rewriting such as below. Enhance the recreational opportunities in the Red Lake River subbasin for the benefit of the local people
5.		The assessment and evaluation sections need to emphasize how each alternative meets or doesn't meet each objective--both study objectives and National Objectives.
6.		The discussion of irrigation appears to assume uncontrolled development. Is this the case? Doesn't the State regulate well drilling? Also, is there any study which discusses groundwater usage and depletion in the area.
7.	Page 22	It is suggested to include relevent social and economic statistics (i.e., population, etc.) and discussion regarding the city of Crookston since Crookston is the location of the majority of the flood damages.
8.	Page 89	It is suggested that additional study needs be outlined which direct research towards new investigations of alternatives to the flooding problems at Crookston since the 100-year protection of levees and floodwall was close to being economically justified.

SUBJECT: Comments on the Draft Red Lake River Subbasin June 1980

Cmt. No.	Page & Para.	Comment
9.	Page 76	The use of portable pumps for interior drainage systems should be agreed to prior to initiating any detailed studies.
10.	Page 82	Alternative 11 noted that the proposed levee would raise the water surface by no more than 0.5 foot. Does this include the impacts due to lost natural valley storage on peak flow magnitudes? This should be noted in the report.
11.	Pages 8-13	Flood Damages. Since the writer went to the trouble of explaining the two types of flooding-overbank and overland-this discussion of flooding should stipulate which type caused the majority of the flooding. Also, if due to rainfall, should be disclosed. Add.
12.	Pages 22-23	Social Characteristics. The discussion of social characteristics should go beyond mere numbers and begin describing the social environment in terms of trends, quality of life, and specific problems. A good social record of a community are the newspapers. Suggest a diachronic analysis of newspaper contents. Add no later than Stage 2. Add.
13.	Page 88	Evaluation. This section should be retitled "Recommendations" and include a definite statement whether to terminate or proceed. The present discussion simply is not clear. Finally, remember that the nonstructural analysis must be carried beyond Stage 1. Add.

STATE OF MINNESOTA
DEPARTMENT OF NATURAL RESOURCES
444 Lafayette Road, Space Center Bldg., St. Paul, MN 55101
PHONE 296-4800 File No

July 28, 1980

Colonel William W. Badger
St. Paul District Engineer
Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, MN 55101

Dear Colonel Badger:

COMMENTS ON RED LAKE RIVER SUBBASIN REPORT

The Division of Waters has reviewed the Red Lake River Subbasin Report. The report provides a good description of the problems and needs of the subbasin. Several concerns were identified during the review of this document.

A major concern involves the determination of benefits for the five reservoir alternatives that are evaluated in the document. During the early 1970's extensive studies were conducted in the Red Lake River Subbasin. The only economically feasible alternative identified by this study was the proposed dam and reservoir at the Huot site. Although local support for this alternative probably outweighed local opposition, the DNR and several federal agencies did not support this alternative because of perceived detrimental environmental effects. The DNR did, however, propose a compromise alternative consisting of a dry dam at the Huot site which it was felt would have better preserved the existing recreational potential. This proposal was not considered to be economically feasible at the time because no lacustrine type recreational benefits could be attributed to it even though it provided a greater or equal amount of flood damage reduction benefits.

Looking over some of the old documents from the investigation of the Red Lake River Subbasin Study it appears as though no flood damage reduction benefits for any of the dam or dam and reservoir alternatives were attributed to East Grand Forks because of the authorized levee project at East Grand Forks. The authorized protection at East Grand Forks has never been constructed and based on the recent review of the Phase I GDM for East Grand Forks, it appears as though the project as authorized does not provide the 100 year flood protection required by state and local laws and regulations. Because of these factors it appears as though some additional analysis of benefits is needed. First, the dam and reservoir alternatives (including the multiple reservoirs) for the Red Lake River Subbasin should be reanalyzed including the flood damage reduction benefits at East Grand Forks. Secondly, since all of the dam and reservoir alternatives apparently have the effect of reducing flood stages at East Grand Forks from 1 to 4 feet, the combination of upstream reservoirs and a smaller local protection works at East Grand Forks (still providing the required 100-year degree of protection) should be evaluated in some detail.

Another related problem is that while the capital costs for Huot Dam and Lake and the other reservoir alternatives have increased substantially since the 1972 price levels, average annual benefits have remained constant even though a large portion of the damages are urban damages. This does not seem intuitively correct. There should have been some escalation in benefits over this period of time. Even if these reservoir projects are determined to be economically feasible, perceived severe adverse environmental effects would have to be resolved before implementation. Several other problems were identified in the text of the document.

Pages 17 and 20.

Although it seems intuitively correct that drainage has affected flood flows in many subbasins of the Red River Valley, very little scientific evidence exists to verify this conclusion. The effects of drainage on flow levels from July through the winter are also unsubstantiated at this time.

* Page 20.

Any proposals to raise the levels on Red Lake to permit the development of hydropower would require consultation with tribal interests.

Page 82.

What are the effects of the extensive channelization measures downstream at East Grand Forks and on the mainstream of the Red River ? It is stated earlier in the report that peak flows on the Red Lake River and the Red River at East Grand Forks frequently coincide. It would appear as though the proposed channelization measures would exacerbate the flooding problems at East Grand Forks.

Thank you for the opportunity to review this document. I hope that these comments are useful and will result in some reanalysis of the alternatives identified in this report and in the final comprehensive report. If you have any questions or comments please contact Joe Gibson at 296-0438 or Ron Harnack at 296-0440.

Sincerely,

DIVISION OF WATERS

Larry Seymour
Director

LS/JG:ph

cc: Don Ogaard
Joe Gibson
Ron Harnack
Gerry Paul

GENERAL COMMENTS
DRAFT RED LAKE RIVER SUBBASIN REPORT
(JUNE 1980)

(These comments apply to the entire report and all subsequent subbasin documents.)

1. This document generally needs additional detailed information concerning nonstructural alternatives. Few of the structural alternatives appear feasible; therefore, unless economics are ignored, nonstructural solutions remain important to reduce the magnitude of future flood damages. Such a discussion on nonstructural alternatives should include considerable information in the formulation, assessment, and evaluation sections. At a minimum the overall report should address and clarify this aspect of flood damage reduction planning.

2. Comments from Federal, State, and local agencies and a letter (with comments) from the St. Paul District will be included in an appendix in each final subbasin and in the overall report. The format for the appendix will be:

   a. Introduction - This section should stress:

      (1) The importance of completing the study on time.

      (2) That the purpose of the study is to advise other agencies and interests.

      (3) The need for a selected review by various interests to provide complete and factual documentation.

      (4) The use of the study as a building block for future water resource efforts.

      (5) That cooperative efforts to evaluate results and develop solutions to remaining problems will be incorporated.

      (6) A complete public involvement program when the study is finished.

   b. The distribution list.

   c. Copies of letters of comment.

   Only comments that identify significant errors or need specific attention will be addressed in the final subbasin report. However, all comments incorporated should be identified with a marking system. The distribution list for the Red Lake River subbasin report is given below:

Agencies receiving draft report	Date sent	Date comments received
Federal		
Soil Conservation Service	19 June 1980	24 June 1980 and 26 June 1980
Fish and Wildlife Service	19 June 1980	4 August 1980
Corps of Engineers, North Central Division	23 June 1980	18 July 1980
Corps of Engineers, St. Paul District	19 June 1980	24 June 1980

Incl 2

Agencies receiving draft report	Date sent	Date comments received
Minnesota		
Water Planning Board	19 June 1980	-
Department of Natural Resources	19 June 1980	28 July 1980
Minnesota State Planning Agency	19 June 1980	-
Water Resources Board	19 June 1980	-
Local		
Watershed District	21 June 1980	-
Flood Control Association	21 June 1980	-
Northwest Regional Development Commission	21 June 1980	-

3. The source for most information identified in the majority of the tables is Gulf South Research Institute. If other sources were used, an appropriate reference should be made.

4. The evaluation section of each report is primarily the recommendations of the document. Generally only the structural alternatives which have a benefit-cost ratio greater than 1 are presented. Little attention is given to the other structural and nonstructural alternatives that may be important aspects of future flood damage reduction planning for the subbasin and basin as a whole. Some of these alternatives may provide the necessary environmental conditions to warrant future efforts. Therefore, this section should be expanded to provide the appropriate discussions.

5. Rather than stating in each report and for each alternative evaluated that there will be no or negligible effects on cultural resources, the report should indicate that it is not possible to identify effects on cultural resources until a systematic cultural resources survey has been completed in the subbasin. Such statements are misleading because it appears that there are no significant sites in the subbasin. In reality, there are simply no known sites and the document and tables should be modified, as appropriate.

6. The supporting information for alternatives including technical, economic, and any environmental data should be provided (at least under separate cover). This would simplify matters when questions are asked during review or in the future.

7. The maps should have more detail. Often information in the text is not clearly illustrated on the maps. These maps would be improved if reproductions were of better quality and included township lines or relationships of subbasin to counties or State lines.

8. All references from the same source should be listed chronologically. References from the same source during the same year should be listed alphabetically. References to the U.S. Army Corps of Engineers should be standardized to read "St. Paul District, U.S. Army Corps of Engineers."

U.S. ARMY, CORPS OF ENGINEERS
ST. PAUL DISTRICT

SPECIFIC COMMENTS ON THE DRAFT
RED LAKE RIVER SUBBASIN REPORT
JUNE 1980

*1. Page 4, paragraph 1 - Counties in the subbasin are incorrectly listed and some are not indicated on the maps in the draft report. Beltrami County is not listed as being in the subbasin. Also, the Red Lake Indian Reservation should be mentioned as being in the subbasin.

*2. Page 4, last paragraph - "Stream" can be defined as being a small river. Would suggest using "waterway" instead of "stream" to avoid any confusion.

* 3. Page 7, Nature of the Problems, paragraph 2 - What is short, in short growing season, compared with? What is the length and range of the growing season?

4. Page 11, top paragraph - It is mentioned that urban flooding in Crookston is "the most critical flooding problem in the subbasin." Yet figures comparing urban and rural flood damages for the 1975 and 1979 floods (page 12, tables 1 and 2) show much higher rural damages. Please clarify.

* 5. Page 11, paragraph 2 - Delete "dollars" after $650,000.

6. Pages 10-13, Flood Damages section - In table 1 on page 12 and in the explanation of the table on page 11, the damage figures given for the 1975 and 1979 floods are much less than the average annual damages. If those floods were of any significance, should the damages incurred be much higher than the average annual damages? Also, damages at Crookston should be mentioned.

7. Page 14, Recreational Problem - A statement on recreational demand would be helpful. Also, information on recreational demand from outside the home should be included.

8. Page 15, Water Quality Problems - paragraph 1 - Explain why the Minnesota Pollution Control Agency and Upper Mississippi River Basin Commission (Souris-Red-Rainy Office) have different statements on what is an "adequate flow" for the Red Lake River.

* 9. Page 17, Wastewater Management, paragraph 1 - 19 + 8 + 6 + 2 + 1 = 36, not 37.

*10. Pages 17-20, Hydropower - A discussion of the rights of American Indians to manage water in the Red Lakes should be included. Reports that fail to mention this are potentially problematic. The Red Lake Reservation is one of the few "closed" status reservations in the country and as such retains rights under treaty and law that most reservations do not. The control structure on Red Lake is thereby treaty and any raise of it or lake level would entail permission from the reservation.

*11. Page 20, Public Perception, paragraph 1 - While the public's perception of problems and solutions may be adequately defined for a reconnaissance report for this subbasin (unlike many of the subbasins), the use of "well defined" may be too strong a statement. This qualification should be added to the first paragraph.

*12. Page 20, Public Perceptions, paragraph 3 - There should be some delineation between what the commission says people feel are strong needs and what the people themselves feel are strong needs. A questionnaire given to a committee is not the same as one given to the general public.

*13. Page 22, Social Characteristics, paragraph 1 - The third sentence reads in part, ". . . all of the counties within the subbasin increased in population." The seventh sentence reads, "Red Lake County's population decrease was the result of outmigration (5.0 percent)." Please clarify.

14. Page 22, Social Characteristics, paragraph 3 - What is meant by "close knit"? Since this is an ambiguous term, an explanation would be helpful. This comment also applies to other subbasin reports.

*15. Page 22, Social Characteristics - Is outmigration intended to be net migration? If so, insert the word net before the word outmigration.

*16. Page 23, Social Characteristics, last paragraph - How can the minority population be too small to be identified? There is a major Indian reservation within the subbasin that contains more people than all but two of the towns that are mentioned. Three thousand people is not such a small population that it cannot be identified, and all 3,000 of these people are defined as having minority status. Also, 3,093 persons is an exact number; why is it called an estimate?

17. Page 24, paragraph 1 - "Unemployment rates . . . average approximately 50 percent," should also have a numeric value. Page 23 lists a total of 3,093 persons on the reservation, but what is the size of the reservation work force?

18. Page 24, Income - What was the correction factor used to convert figures to 1979 dollars? It would be helpful to include this. Also include income distribution, such as the percentage of population below the poverty level.

19. Page 24, Income - When comparing income increases between two periods of time, use both a numeric and percentile comparison. Also, the report needs to compare the percentage of increase in the State with the subbasin figure.

20. Page 24, Income, paragraph 1 - How much income is being discussed? It would be more meaningful to compare incomes of the east and west halves of the subbasin. What is the total amount of farm income for the basin? It cannot be determined from the information given.

21. [illegible] - In addition to the factors noted on yield per acre, [illegible] total production for particular crops, it would be [illegible] per acre for particular crops were included. This would give a better understanding of the relative importance of [illegible] another factor that would aid understanding of flooding problems is the differential in susceptibilities of crops to flood damages. Some crops are not as seriously affected by a flood event as others. In addition, the differential in costs per acre to plant particular crops would aid understanding.

*22. Page 25, Table 4 - Round off the total production figures to the nearest 10.

*23. Page 26, Table 5 - Should the column one heading be SIC, instead of S/C?

*24. Page 27, Land use, last paragraph - The floodplain is referred to as "an important agricultural area . . ." However, the floodplain map on page 19 does not seem to confirm this. It only shows a narrow band of floodplain area around main rivers. Also, the last paragraph on page 10 reads, "Cultivated areas in the narrow floodplain . . . are scattered and limited in size . . . agricultural flood damages are relatively minor." There seems to be some discrepancy.

*25. Page 35, Water Supply, paragraph 1 - The "latest figures" from the Minnesota Department of Health are cited. What year were these figures published?

26. Page 44, Social - In addition to the information presented, a discussion of the social consequences or implications of flood events should be presented, particularly those concerning behavioral damages that may occur.

27. Page 45, paragraph 1 - Why is there a decrease in the levels of fish productivity?

28. Page 48, paragraph 1 - The source of information for the wetlands data is not adequately referenced in the bibliography. The information cited was in a separate letter report and not a part of the U.S. Fish and Wildlife Service 1980 Terrestrial Resources package. The wetlands report should be cited separately.

*29. Page 50, Threatened and Endangered Species - The peregrine falcon has apparently been extirpated from Minnesota since the early 1960's. Although the subbasin does lie within the migratory route of the peregrine falcon, and sightings may occur in the region at this time, the current wintering range of this species is south of this subbasin.

30. Page 52, Other Important Species -

*a. The eastern greater sandhill crane is considered threatened by the Minnesota DNR but is not listed federally as threatened or endangered.

*b. Although coniferous swamps may be used by great blue herons as nesting areas in this region, it is not the only suitable habitat type. Nesting habitat in Minnesota also includes tall deciduous trees that may be live or dead. The sentence should read: "This species . . . scarcity of its nesting habitat such as coniferous swamps."

*31. Page 54, paragraph 2 - The Dakota skipper is no longer proposed as endangered. The U.S. Fish and Wildlife Service failed to determine its status within the required 2-year period. However, it may be listed as rare by the Minnesota Natural Heritage Program. This should be discussed, as appropriate. Also, on page 55, Potamogeton labenaks should be underlined if it is a proper botanical name. The same goes for other similar names.

*32. Page 62, Institutions, paragraph 4 - Red Lake Reservation Tribal Council "must" also be consulted, not "should." Suggest this change be made in order to comply with the December 1979 policy clarification from the Department of the Interior.

33. Pages 64-65, Nonstructural Measures - Do other municipalities and towns have floodplain zoning ordinances, building codes, and subdivision regulations for floodplain areas? Some explanation of the existing situation would be helpful.

*34. Page 67, Floodplain Management Criteria, paragraph 3 - The second sentence should read: "Tangible economic benefits or appropriate gains in environmental quality must exceed overall costs."

35. Formulation of Alternative Measures - There should be a more extensive discussion of the possible impacts and benefits of nonstructural alternatives.

*36. Page 75, Point number 4 - "April 1975" should read "April 1979." This is the date of the supplement to the original reconnaissance report, which is dated March 1975. While the original report found economic feasibility, the supplement found it lacked economic feasibility.

*37. Page 87, Farmstead Levees - A discussion on the impacts of farmstead levees should include an assessment of possible effects on cultural elements.

*38. Page 88, paragraph 1, seventh line - It should be "floodwall," not "floodwell."

39. Page 89, Additional Study Needs - The probability of institutional and social boundaries being the same is remote. Since this boundary overlap exists, integrated basin-wide social and institutional analyses are desirable.

40. The St. Paul District is currently conducting three reconnaissance reports under Section 14 of the 1946 Flood Control Act (Emergency Bank Protection) in this subbasin. They are all on the Red Lake River: one is in Red Lake County, one is near Crookston, and one is near Gentilly.


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